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CONTENTS.

The Common Cockroach.—IV. By E. A. BUTLER 1
The Fish Lizards of the Secondary Rocks. By R. LYDEKKER, B.A., Cantab. 3
The Ethnological Significance of the Beech. By Canon ISAAC TAYLOR, Litt.D., LL.D. 5
Drawings of the Milky Way. By A. C. R. 6
Some Properties of Numbers. By ROBT. W. D. CHRISTIE 7
Colour Blindness. By RICHARD BEYNON 8
On Large Telescopes. By A. C. RANYARD 9
Barnacles. By S. HEYWOOD SEVILLE 10
Notices of Books 12
Letters:—W. STANIFORTH, H. COMBES 16
The Face of the Sky for November. By HERBERT SADLER, F.R.A.S. 17
Whist Column. By W. MONTAGU GATTIE 18
Chess Column. By I. GUNSBERG 19

THE COMMON COCKROACH.—IV.

By E. A. BUTLER.

IN order to complete the sketch already given of the digestive system, we have yet to notice some important accessory organs, the salivary glands, which in the cockroach are enormously developed. On opening the body, they may be seen lying along just outside the walls of the crop in its anterior part. Each consists of a pair of white glands (Fig. 9) and a very thin-walled, elongated bag or receptacle, quite distinct from these; each gland, though apparently compact, really consists of a flattened tree-like structure, the foliage portions of which contain the cells which secrete the saliva, while the branches are minute tubes which convey it, when secreted, from the gland. A narrow tube, or "duct," formed by the union of the above branches, receives the salivary fluid from each gland, but the two ducts of each side soon unite into a single one, and the two thus formed again coalesce and form one main central tube lying under the œsophagus. Similarly the ducts of the receptacles unite in a single central canal, which receives, a little beyond this junction, the common duct of the glands, and so finally only one tube remains as the representative of the original six, and this opens into the mouth behind the tongue.

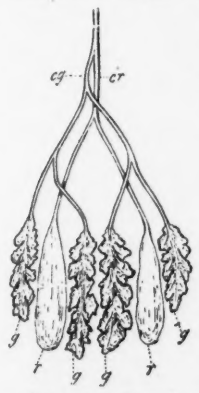

FIG. 9. — SALIVARY GLANDS OF COCKROACH. *g*, glands; *r*, receptacles; *cg*, common duct of glands; *cr*, common duct of receptacles.

Like other terrestrial insects, a cockroach breathes by taking in air, not through its mouth, but at certain openings in the sides, called spiracles, or *stigmata*. There are ten of these on each side, eight pairs being situated in the abdomen and the other two in the thorax. Those belonging to the abdomen are not very easy to detect, as they are small and all but one pair obscurely situated. The chitinous integument which bounds and determines the form of each segment of the abdomen is not a complete ring round the body, but consists of two distinct parts, a band across the back, called the *tergum*, and another underneath, the *sternum*; these are united towards their edges by a membranous junction, and it is in this at the junction of the segments that the stigmata lie, concealed by the overlapping edges of the terga and sterna. Each is an oval aperture situated on the summit of a small conical eminence (Fig. 10), and capable of being closed by an internal valve, whereby dust and other foreign matters are excluded. A large tracheal tube proceeds from each, and very soon begins to subdivide into smaller ones, the ultimate ramifications of which pass to the remotest parts of the body, and even into the jaws, wings, legs, and antennæ. By means of this system of tubes air is conveyed to all parts of the organism, so that the blood is aërated, not, as in most kinds of animals, by being brought from the body at large and collected in some special organ, such as a lung or a gill, there to come into contact with the air, but by having the air conveyed to it in all parts of the body at once.

FIG. 10.—ABDOMINAL SPIRACLE OF COCKROACH.

The introduction and expulsion of air is, of course, accompanied by movements of the body walls, but these are not very easy to see as they are but slight in amount. Plateau succeeded in demonstrating their character and extent by the ingenious method of projecting the form of the body of the living insect on a screen by means of the lantern, and then tracing its outline during inspiration and expiration respectively. In general, an insect at rest performs its respiratory movements with the hinder part of its body, in other words, it pants with its *abdomen*, the movements consisting of an alternate contraction and recovery of shape of that region. Amongst British insects there is perhaps no species in which it is easier to watch these movements than the great green grasshopper, a large locust-like insect found not unfrequently in some parts of the country. By the contraction of certain abdominal muscles, the upper and lower walls of the abdomen are drawn together to the extent, in the cockroach, of one-eighth of the entire depth of the body, and a compression from side to side takes place at the same time; the tracheal tubes are thus compressed, and air is forced out at the stigmata; on the relaxation of the muscles, the elasticity of the tracheal tubes themselves, resulting from the coiled spiral thread in their interior, then restores the body to its normal form, while air in consequence enters at the stigmata. In the cockroach, the thoracic segments have sufficient mobility to permit of their taking some part in the movements of respiration, even when the insect is at rest, in which respect it differs from most other insects. In order, therefore, clearly to realise how a cockroach breathes, we have to bear in mind that, concurrently with the rise and fall of the body walls, ten little jets of air alternately enter at and issue from as many openings in the insect's sides, the outward-tending jets of course carrying with them the carbonic acid and water vapour produced as the insect discharges its vital functions.

But the respiratory movements above described can scarcely be regarded as providing a complete explanation

of the mechanism of breathing. For they would simply have the effect of renewing that portion of the contents of the tracheal tubes which is in the parts nearest the spiracles, and the air in the minute and remote subdivisions of the tracheæ would have no chance of being expelled, and would simply oscillate up and down the tubes and never reach the outer air at all. How this difficulty is met is not at present altogether clear, but it seems certain that we must look to the principle of gaseous diffusion as at any rate aiding in producing the required result of the penetration of oxygen to the remotest parts of the system, and the corresponding outward passage of the carbonic acid formed. The rate of breathing depends upon a variety of circumstances. It is quickened by whatever increases the general activities of the insect; thus, a swiftly running cockroach breathes more quickly than one at rest, and, again, a well-fed individual is naturally more vigorous and inclined for exertion than a lean and emaciated one, and its respiration becomes in consequence more rapid. Cold, on the other hand, has a benumbing effect, and the rate of breathing therefore falls with the temperature.

The extreme perfection of the respiratory system is closely connected with and correlated to a very rudimentary condition in the circulatory apparatus. As the air is conveyed to every part of the body, and oxygenation can take place anywhere, there would clearly be no object in having any special apparatus for the collection and guidance of the blood. A cockroach has indeed, as already mentioned, a heart, but beyond this it can scarcely be said to possess any circulatory system. Anyone who brings to the examination of a creature such as this the popular conception of what a heart is like, will certainly fail to find anything which bears the remotest resemblance to such conception. There is, in fact, no compact, chambered, fleshy, conical body such as we are familiar with in vertebrate anatomy; the "heart," so called from its function, not its form, is merely an inconspicuous, elongated soft tube, with sundry openings in its sides through which blood enters it from the body at large. Nor is its position such as might have been anticipated; we must look for it, not towards that side of the body which faces the ground, but on that which is uppermost, for it lies along the whole length of the back, just beneath the skin, in the middle line. Nor, again, does this rudimentary heart communicate with any system of blood-vessels for conducting the blood on its tour round the body; for the blood, on being expelled from the orifice at the extremity of the tube, is simply passed on through the various interstices between the different viscera, until it ultimately finds itself back again at the place it started from. Hence it is manifest that every movement of the body which in any way disturbs the relative position of the internal organs will assist, to some extent, in urging the blood along its course. Nor, finally, is the blood itself exactly what its name might suggest; if a cockroach is wounded, blood will, of course, issue from the wound, but as it is only a colourless liquid, a little stretch of the imagination is required to realise that it is the true nutrient fluid of the body.

By the dissection which removes the digestive tract, the main part of the nervous system is laid bare. It is constructed similarly to that of the earthworm, and consists of a chain of nervous centres or ganglia, in pairs, connected with one another by nervous threads (Fig. 11), and extending from one end of the body to the other. The greater part of it lies between the digestive tract and the under surface of the body, and is therefore nearest the ground when the animal walks. Here again, therefore, all preconceived notions gathered from the familiar vertebrates are upset, as we trace the great nerve-centres, not down the back, but in exactly the reverse position. The foremost pair of ganglia, however, which are situated in the head and have been dignified with the name of "brain," as they send nerves to the sense organs, viz. the eyes and antennæ, lie above the œsophagus, being connected by two thick bands of nervous tissue with the first pair that underlie it, so enclosing that portion of the digestive tract as in a collar. While examining the distended crop as it lies in its natural position, a small nervous ganglion may be observed as a little triangular whitish spot on its upper surface about half-way down its length; from this two nerves pass obliquely backwards towards the hinder part of the crop, while a single one running forward along the middle line connects this centre with some small ganglia in the neighbourhood of the brain. This small collection of nerves and ganglia is called the visceral nervous system.

Fig. 11. — Nervous Chain of Cockroach. *a*, supra-œsophageal ganglia; *b*, sub-œsophageal do; *c*, thoracic do.; *d*, abdominal do.

Such is the insect which foreign commerce has introduced to our island, and which, by reason of the persistence with which it clings to the fortunes of the human race, has become truly cosmopolitan, and seems to be almost a necessary adjunct of modern civilisation. Nowhere a welcome guest, it yet quietly pushes on its conquests, and even the determined hostility of the tidy housewife does not avail to check its progress. Its nocturnal habits and love of concealment make it a very difficult insect to eradicate when once it has established itself in a house, and it is to be feared that no certain remedy for this nuisance has yet been discovered. Spite of "beetle-traps" and "vermin-powders," it maintains its ground; neither rats, cats, nor hedgehogs (all numbered amongst its foes, and the last especially a greedy devourer of it), are able materially to lessen its numbers; by reason of some subtle superiority, perhaps impossible for our gross senses to perceive, it continues to be victorious over all its enemies, and in the face of all opposition and efforts to exterminate it, still flourishes and continually spreads. It is, indeed, gradually dislodging an old and familiar inhabitant of kitchens, the house-cricket, an insect of very similar habits to itself, and no very distant relation of its own.

P. orientalis is not the only species of cockroach which attaches itself to man. A considerably larger species, *P. Americana*, which is winged in both sexes, has spread a good deal from its native haunts in Tropical America, and has effected a lodgment in some places in this country. But for some reason or other, it does not seem likely to displace *orientalis*, a curious fact, inasmuch as it is a stronger insect, and, being gifted with wings in both sexes, might be supposed to have had better opportunities of establishing itself. It is a common species on board ships. An Australian species also appears to be beginning to spread. Again, *Blatta germanica*, a closely allied form called in America the "Croton Bug," is known all over the United States, and sometimes gets a footing in Britain. In a baker's shop at Leeds it established itself, and is said to have been introduced by soldiers after the Crimean War, coming with them to the barracks, and being thence conveyed to the bakery in bread baskets. According to

Hummel, this species assists its young to escape from the egg case; he introduced a female into a bottle containing one of the cases; she immediately seized it, and slit it open with her jaws, and tore off the enveloping membranes of the contained young.

Besides house-cockroaches, we have in this country field-cockroaches, *i.e.* indigenous species that habitually live out in the open and do not attach themselves to mankind. They are smaller than *P. orientalis*, and may be found in sandy places and amongst dead leaves and other vegetable rubbish. They have sufficient superficial resemblance to *P. orientalis* to be recognisable as coming into the same category, although their colour is generally much paler. In addition to these, large numbers of species occur wild in other countries; but why just those particular species mentioned above, and especially *P. orientalis* itself, should have become dependent upon the human race, while so many others have either not attempted to do so, or have not succeeded if they have attempted, is still shrouded in mystery. The chief peculiarity by which *orientalis* is distinguished from its fellows, viz. the apterous condition of the female, seems rather as though it might militate against its chances than favour them.

THE FISH-LIZARDS OF THE SECONDARY ROCKS.

By R. Lydekker, B.A., Cantab.

So long ago as the year 1814, when a fine example of a large skull (now in the British Museum) was figured by Sir Everard Home in the "Philosophical Transactions" of the Royal Society, the occurrence in the so-called Lias of the Dorsetshire coast of skeletons of huge and uncouth reptiles, strangely unlike any of their modern cousins, was well known. Five years later the same writer described other specimens, and proposed that these extinct Saurians should be known as the *Proteosaurus*, or Primeval Lizard. Now, strictly speaking, this name, as the earliest, ought to have been adopted for all time, but, unfortunately, the late Mr. König, some time keeper of the Geological Department of the British Museum, affixed to the specimens of these Saurians under his charge the name of *Ichthyosaurus*, or Fish-Lizard; and this name was adopted in the year 1821 by the late Rev. Mr. Conybeare, who, in conjunction with the late Dean Buckland, of Oxford, did so much towards our knowledge of the structure of these and other fossil Saurians. This name has now become so thoroughly established—being, in fact, almost an English word—that, in spite of the injustice to Sir Everard Home, it seems too late to attempt its suppression.

We have said that the Fish-Lizards have left their remains in those beds of rock which are called by the quarrymen Lias, or Layers (the name being derived from their banded and ribbon-like appearance); and before proceeding to discuss the structure of these creatures, a word or two is advisable as to the geological position of the formation. The Lias comprises a thick series of beds, usually of a bluish colour, lying very low down in that enormous series of rocks known as the Secondary system, of which the Chalk is the topmost member, while the middle part of the system is formed by the great series of Oolites and their accompanying clays. The Secondary system itself, it need hardly be said, lies upon the upper part of the Primary system, as represented by the Coal Measures; while it is succeeded by the overlying deposits of the Tertiary system. In regard to the upper parts of the latter system, it is possible to make some more or less vague approximation in terms of thousands of years as to their real age, but in the Secondary period any such approximation is totally impossible, and we can only reckon the age of the various beds by geological periods, as represented by the vertical thickness of overlying rock. Now, since the Chalk may exceed 1,000 feet in thickness, and there are several deposits of equal bulk between this and the Lias, some faint idea may be thereby conveyed of the vast lapse of time by which we are separated from that period when the mud of the Lias was deposited in the shallow seas of what is now England. The Fish-Lizards were, however, by no means confined to this remote Liassic period, since they also occur not only in the underlying New Red Sandstone, or Triassic series, which forms the very base of the Secondary system, but likewise lived on through the period of the Oolites and Chalk, till they finally died out, so far as we are aware, with the close of the Chalk period. The Fish-Lizards are, therefore, characteristic of the Secondary period, so that when we pick up one of the joints of their backbones (of which more anon) we know that it must have come from some part of that great system, even though we find it embedded in the gravels lying above the Tertiary system. One more important point remains to be mentioned in connection with the beds in which the remains of these Fish-Lizards occur; and this is, that they are all deposits formed by the sea, by which we are led to conclude that these saurians were of marine habits. Again, it may be observed that whereas in the Lias the remains of the Fish-Lizards are usually found in the condition of more or less nearly complete skeletons, with every bone but little shifted from its natural position; in the overlying rocks the skeletons are generally more or less dislocated and imperfect. Although the latter condition renders us unable to restore the complete skeleton of these latter forms, yet it has had the compensating advantage that we are able to handle and examine the individual bones in a manner which is generally quite impossible with the skeletons from the Lias, where the bones are often distorted and flattened by pressure.

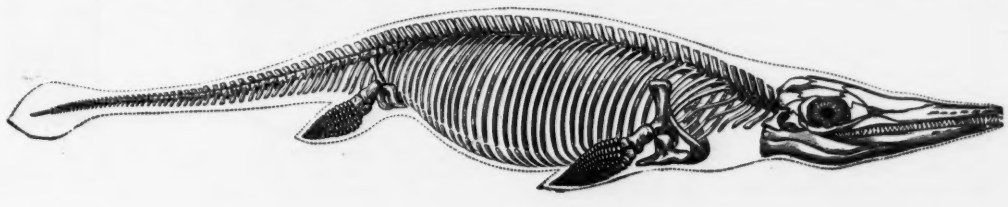

Fig. 1.—Greatly Reduced Restoration of the Skeleton of the Common Fish-Lizard of the Dorsetshire Lias.

We are now in a position to consider a few of the more prominent features in the structure of these primeval

saurians; of which the whole organisation is better known than that of most of the other reptiles of the same epochs. In the woodcut (Fig. 1) we give a copy of Sir Richard Owen's restoration of the entire skeleton, together with a conjectural outline of the contour of the body when clothed with flesh and skin. It will be seen from this that the contour of the entire animal was of a whale-like type; there being no distinct neck, the body gradually passing into the tail, and the two pairs of limbs forming paddles or flippers, adapted, like those of a turtle, for propelling the body through the water, and perhaps also permitting their owner to crawl awkwardly on the sea-shore in the same manner as the turtle does. From the circumstance that in the skeletons from the Lias the tail is nearly always broken at some distance from its extremity, it has been suggested that the tail was furnished with a terminal fin, after the fashion of the "flukes" of the Whales. In some instances the fine-grained Lias mud has preserved traces of the outer surface of the skin of the Fish-Lizards, and we learn from this, and also from the absence of any traces of bony plates like those found in the skin of crocodiles, that the skin of these saurians was quite naked; and we are thus shown another feature in which they resemble whales. Moreover, in certain very rare instances, as is shown in the beautiful example represented in Fig. 2, which has been

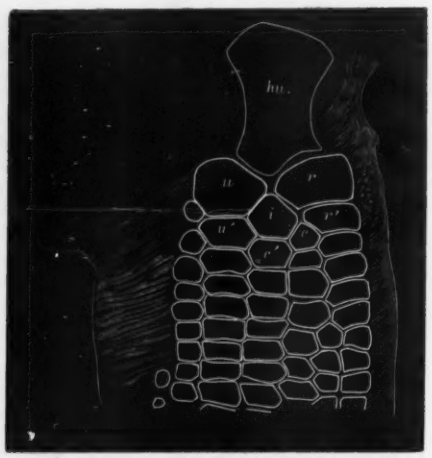

Fig. 2.—Part of one of the Fore Paddles of a Small Fish-Lizard from the Lias of Barrow-on-Soar. *hu*, bone of upper arm; *r*, *u*, bones of fore-arm; the other letters indicate the bones of the wrist, below which are the bones of the fingers.

recently presented by Mr. M. Browne, of the Leicester Museum, to the National Collection, the contour of the soft parts of the paddles is accurately delineated in the stony matrix. We thus see that the fleshy part of the paddle formed but a comparatively narrow band in advance of the bony framework on the front border of the fin (right side of Figure); but on the opposite or hinder border (left side of Figure) we find the soft parts forming a broad fin-like expansion admirably adapted to obtain the full advantage of the stroke of the limb in swimming.

As we are on the subject of the paddles, we may take the opportunity of noticing the very remarkable structure of their bony framework, which is quite unlike that found in any other animal, although evidently only a modification of the same ground-plan. In most vertebrate animals, as in man, the skeleton of the arm, or fore limb, presents the following features:—The upper-arm has one long single bone; in the fore-arm there are two slender bones lying side by side and separated by an interval; the wrist has two rows of small cuboidal bones; while the limb terminates in five fingers, of which, with the exception of the thumb, each has three long bones, which are respectively separated from the wrist by a similar but somewhat longer bone. Turning to the fore paddle of the Fish-Lizard (Fig. 2), we easily recognize in the topmost bone the single bone of the upper arm, although this has become much shorter and thicker than is usually the case. In the two short and angulated bones, marked *r* and *u*, it is more difficult to recognize the representatives of the long bones of the fore-arm; but that they really are such representatives is at once shown by their position. Passing over the bones of the wrist, we find that the bones corresponding to those of the fingers, instead of being elongated and limited to three in each of the five fingers, are polygonal in contour, and arranged in as many as seven or eight longitudinal rows, while those of each finger (as shown in Fig. 1) are exceedingly numerous. The whole structure forms, in fact, a complete bony pavement, which in the living animal must have been perfectly supple, and thus have formed one of the most efficient and powerful swimming organs known in the whole animal kingdom. The paddles of the whales resemble those of the Fish-Lizard in the great number of bones in each finger, but they differ in that the number of the fingers themselves does not exceed the universal five.

In the few words that we can devote to the skull of the Fish-Lizard, we may observe that the muzzle was produced into a more or less elongated beak (Fig. 1), while the nostrils were placed close to the eye, and the soft parts of the latter were strengthened with a ring of bony plates surrounding the iris and pupil, as is the case in birds. The teeth were large and pointed, and implanted in a deep groove in the jaws. Their pointed crowns at once tell us that the Fish-Lizards were creatures of carnivorous habits, which preyed on other inhabitants of the Secondary seas. Curiously enough in the approximation of the nostrils to the eyes, and also in their sharply-pointed teeth, the Fish-Lizards present further resemblances to the Whales, resemblances which we may probably explain by the similar conditions of life of these two widely different groups.

Before leaving this brief notice of the anatomy of these saurians, a few words must be said as to the structure of the back-bone or vertebral column. It will be seen from Fig. 1 that the whole of this column forms a continuous

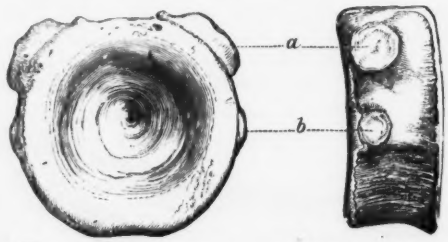

Fig. 3.—End and Side Views of the Body of One of the Segments of the Back-bone of a Small Fish-Lizard. *a*, *b*, Surfaces for the attachment of the rib.

series, tapering at the two extremities; and the various segments, or vertebræ, of the different regions of this column are so alike that it requires some practice to distinguish them. As is well known, each vertebral segment in all the vertebrate animals consists of an arch enclosing the spinal marrow, and of a sub-cylindrical body supporting the arch and underlying the marrow. As a rule, the body and the arch are more or less firmly united together, but

in the Fish-Lizards they remain quite separate throughout life. Further, the body of each vertebra (Fig. 3) forms a disk, which is deeply concave at the two extremities, like the vertebræ of a fish, and quite different from those of most living reptiles, in which the bodies of the vertebræ articulate with one another by a ball-and-socket joint. Another peculiarity of the back-bone of the Fish-Lizards is in the mode of attachment of the ribs. Thus each rib terminates in a fork, of which the two prongs articulate with the two knob-like surfaces on the side of the body of each vertebræ, as shown in Fig. 3.

Some of the species of Fish-Lizards attained a length of from thirty to forty feet, and were thus truly Leviathans of the deep.

The result, then, of our brief survey of the chief structural peculiarities of these extinct saurians is to show that they were Whale-like marine reptiles of carnivorous habits, with a naked body, provided with four paddles, and probably with a tail fin, and that they had fish-like vertebræ, and a long-toothed beak to the skull. In certain American representatives of the group the jaws were, however, totally unprovided with teeth; and in these and allied types from the Oolites of England a third bone articulated with the bone of the upper arm (*hu* of Fig. 2), thus making the structure of the paddle still more peculiar. How these toothless Fish-Lizards captured and held their prey is not very easy to understand; but it is possible that instead of living on hard mail-clad fishes like their toothed cousins of the Lias, their food may have been of a softer nature, such as cuttle-fishes.

In stating that the Fish-Lizards of the Lias subsisted largely on the mail-clad "Ganoid" fishes of the same epoch, we may perhaps be thought to be drawing upon our imagination. This, however, is not the case, since we frequently find the whole contents of the stomach of these reptiles preserved within the cavity of their ribs, which shows us that their food was composed not only of these fishes, but also of young individuals of their own genus. In very rare cases, moreover, there are found within the body-cavity of large individuals very small skeletons of other Fish-Lizards; and since these young skeletons are always entire and belong to the same species as the one within whose body they are enclosed, it has been concluded that some Fish-Lizards brought forth their young in a living condition. This conclusion being certainly one of the most startling and unexpected results which has rewarded the students of this branch of palæontology.

Whether, when the name of Fish-Lizards was first given to these saurians, it was in the mind of its author that they were really related to fishes, cannot now be certainly known. It has, however, been subsequently suggested that these reptiles are the direct descendants of fishes; but since, like Whales, they breathed air by means of lungs, a recent writer has pointed out that if such descent were really the case it is almost certain that the Fish-Lizards would have continued to breathe air by means of gills, after the manner of fishes. And it is, therefore, considered probable that these saurians are the descendants of still earlier land reptiles; in which respect they again present another resemblance to Whales, which, as Professor Flower has shown, appear to have been derived from land animals more or less nearly allied to the hoofed quadrupeds or mammals. If, now, we look back and endeavour to fix upon the ancestral type of reptiles from which the Fish-Lizards have probably been derived, we find that in the period of the Coal and the succeeding first stages of the Secondary epoch there existed a remarkable group of reptiles, which, in the adult stage, were inhabitants of the land and breathed by means of lungs. From the very peculiar labyrinth-like internal structure of the teeth of these early reptiles the group is collectively known as the Labyrinthodonts. Now it is very suggestive that the teeth of most species of Fish-Lizard retain traces of this very remarkable labyrinthic structure; and since, moreover, the skull of these saurians has certain peculiar features also found in that of the Labyrinthodonts, while the structure of the backbone is very similar in the two groups, it seems highly probable that the Fish-Lizards have been directly derived from ancient reptiles more or less closely allied to the Labyrinthodonts, if not from that group itself; and that as they gradually became more completely aquatic their limbs were developed into the very complex paddles of the typical forms.

In conclusion, we have already pointed out several remarkable resemblances between the ancient Fish-Lizards and the modern Whales, and we have regarded such resemblances as due to their similar mode of life. The Fish-Lizards may, indeed, be considered to have occupied that place in the Secondary period which is now held by the Whales; and it becomes curious to reflect why these saurian devastators of the deep should have died at the close of the Secondary period, to be succeeded during the Tertiary by the mammalian Whales. This, however, is unfortunately just one of those deeply interesting problems to which science gives us no answer.

THE ETHNOLOGICAL SIGNIFICANCE OF THE BEECH.

By Canon Isaac Taylor, Litt.D., LL.D.

THE new science of linguistic palæontology has thrown a flood of light on several obscure problems of ethnology. It has, for instance, been proved that the names of the ass and the camel in Aryan languages are not primitive, but merely loan words from the Semitic. This fact, by itself, goes far to disprove the hypothesis which placed the cradle of the Aryans in Central Asia, a region of which these animals are natives.

Perhaps in no case have more valuable results been obtained than in the case of the beech. This tree, which flourishes only in temperate climates, and is a lover of chalk sub-soils, is confined to a definite and restricted area. It grows in the extreme south of Norway and Sweden, but is not found east of a line which strikes across Europe from the Frische Haff on the Baltic coast near Königsberg, through Poland to the Crimea, ending finally in the Caucasus.

In former times the limit was more narrowly restricted. In Cæsar's time the beech had not reached Britain or Holland, while at the close of the bronze age, or the beginning of the iron age, it was only just beginning to replace the oak in Denmark. Early in the neolithic age its range was probably confined to France, Northern Italy, and Northern Greece, while in Germany, as Dr. Schrader believes, it did not extend north of the Thuringian forest. It flourishes in Macedonia, and clothes the north-eastern slopes of the Thessalian coast chain, while in the south of Epirus the ilex or evergreen oak replaces it as the characteristic forest tree.

Within these ancient limits of the beech we must place the cradle of four Aryan languages—German, Latin, Celtic, and Greek. We draw this conclusion from the following philological facts:—The word for beech is, in Gothic, *boka*; in Latin, *fagus*; in Celtic, *faidhbhile*; while the corresponding word, φηγός, denotes the oak in Greek.

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With regard to other members of the Aryan family, the names for the beech, *buky* in old Slavonic, *bukas* in Lithuanian, and *buk* in Russian, are manifestly loan words from the German. This would go to prove that the Slaves, in the prehistoric period, must have dwelt east of the beech line, though they have since advanced within it. Johannes Schmidt has shown reason for believing in the unbroken geographical continuity of the European Aryans, previous to the linguistic separation. Hence they must be placed astride, so to speak, of the beech line—the Slaves and Lithuanians in European Russia, and the Celts, Latins, Hellenes and Teutons farther to the west.

We have now to account for the fact that the word denoting the beech in Latin, German, and Celtic, has come in Greek to denote not the beech but the oak. A well-known explanation of the difficulty has been offered by Professor Max Müller in the second series of his lectures. He contends that the word originally denoted the oak, but that it was transferred to the beech at the time when the oak forests of Jutland were replaced by beech forests. But this does not account for the fact that the Latin word *fagus* means the beech, for Helbig has shown that the Umbrians had already reached Italy before the commencement of the age of bronze. The bronze age began in Italy earlier than in Denmark, and in the bronze age the oak was still the prevailing tree in Denmark, and was quite unknown in the neolithic age, when the Umbrians, whose language was a dialect of Latin, were already settled in Italy. The word *fagus*, therefore, must have denoted the beech in Latin at a period prior to the change in the forest growth to which Professor Max Müller attributes the alteration in the meaning of the word.

Moreover, a great change in the vegetation of a country, such as the replacement of the Danish oak forests by forests of beech, must have occupied many centuries, At what moment, then, was the name transferred from one tree to the other? Were the people of Denmark content to have no name for the beech when it first appeared, and what did they call the oak after having deprived it of its original title, in the prolonged period during which the two trees must have been growing side by side?

Another hypothesis, less beset with difficulties, has been advanced by Geiger and Fick, who suppose that the word originally signified the beech, and received among the Greeks the changed signification of the oak. If the Greeks had migrated from a land of beeches to a land of oaks there is no difficulty in understanding that they may have transferred the name of one tree to the other. The word, meaning the food-tree (φαγ ἶν, to eat), would be as applicable to the evergreen oak, with its acorns, as to the beech, the mast of which was the staple food for their swine. The beech, as has been said, is not found south of Dodona, which lies in the centre of Epirus. It is noticeable that the most ancient Greek legends are connected with Dodona, where the Greeks made their first halt in their progress to the south, and where the earliest prophetic utterances were obtained from the rustling of the leaves of the sacred tree — the φηγὸς. Hence we may believe that the Greeks entered the peninsula, not from Asia Minor, but from the north-west, through the valleys of Epirus. This route would explain how the old Aryan word denoting the beech came to be applied by the immigrants to designate the tree which flourished on the hill slopes of their new territory. In modern times we have similar instances of transferred names in the United States, where such English names as the robin, the hemlock, and the maple are used to denote wholly different species.

But with regard to the Greeks, it may be urged that before they entered the peninsula they must have been already acquainted with the deciduous oak, which flourishes in the region whence they emigrated. This objection is met by the fact that the Greeks had a second name for the oak, δρῦς, which corresponds to the old Irish *daur* oak, as well as to the Gothic *triu*, and the Sanskrit *dru* which mean simply a tree. Both of the Greek words for the oak are used by Sophocles in speaking of the sacred oak at Dodona.

The Greek word for the deciduous oak agrees with the Celtic word, while the Greek word for the evergreen oak was the word which in their former home had denoted the beech.

The question as to whether the original Aryan word denoted the beech or the oak is not unimportant, as from it may be drawn an inference as to the primitive seat of the Aryan race.

According to Professor Max Müller, the Aryans migrated from Central Asia, where the beech is unknown. If this had been the case it is extremely difficult to explain how the ancestors of the Latins, Celts and Teutons, migrating, as Pictet maintains, at different times and by different routes, to lands where the beech abounds, should all have chanced to call it by the same primitive name; merely modified according to the fundamental phonetic laws of Latin and German. But, on the other hand, all such difficulties disappear if we assume that the cradle of the Aryans was in the original beech region; that is, roughly speaking, in the valleys of the Rhine, the Main, and the Danube; and that it was here that the differentiation of the Greek, Latin, Celtic, and German languages took place.

The name of the beech bears also on the solution of the question as to which of the neolithic races has the best claim to represent the primitive Aryans. The choice probably lies between the brachy-cephalic Celto-Latin race, some of whose earliest settlements may be discovered in the pile dwellings of Bavaria, Switzerland, and Northern Italy, and the dolicho-cephalic Scandinavian race, whose remains are found in the Danish kitchen middens. That one of these races constituted the primitive Aryan race and imposed its language on the other, is highly probable.

Now, as we have already seen, in the neolithic age the beech had not yet reached Denmark, the fir being at that time the predominant tree. In the bronze age the fir was succeeded by the oak, which gave place in the iron period to the beech. Hence the beech region was at that time inhabited by the Celto-Latin people, while the Scandinavian race in all probability dwelt to the north of its limit.

The beech has therefore a threefold ethnological significance.

(1) It proves that the Greeks entered Hellas from the North, probably through Epirus, and not, as has been contended, from Asia Minor.

(2) It proves that the differentiation of the Aryan languages took place not in Asia, but in Central Europe, on either side of the beech line; the Slaves and Lithuanians being to the east of it, the Greeks, Celts, and Latins farther to the west

(3) It makes it probable that the primitive Aryans belonged to the brachy-cephalic Celto-Latin race, and not the dolicho-cephalic Scandinavians.

DRAWINGS OF THE MILKY WAY.

WE have been requested to state that some large detailed drawings of the Milky Way, made at Parsonstown by the Earl of Rosse's assistant, Dr. Otto Boeddicker, are at present on view at the rooms of the Royal Astronomical Society, Burlington House, and that an explana-

tory note on the subject will be read at the next (November) meeting of the Society. There are three large drawings in all, one showing a little more than the northern half of the Galaxy down to about 10 deg. to the south of the equator on either side of the map, and two other drawings on double the scale of the first, each representing a half of the part of the Milky Way shown in the first map. Dr. Boeddicker's drawings differ in character from the drawings of the Milky Way which have been made by other observers. Heis and Gould may be said to show the Galaxy as made up of cloud-like lumps or masses of light and curiously shaped areas of fainter brightness, whereas Dr. Boeddicker shows it as composed of whisps and streams of light with very numerous dark channels, having more or less sharply defined edges. Every one must have noticed the great dark channel which divides the Milky Way into two nearly parallel streams from Cygnus to Scorpio; but Dr. Boeddicker sees innumerable smaller channels of a similar character branching away from the main channel and frequently following the central line of outlying streams of nebulous light, which curve so as to include stream lines of brighter stars. If the existence of such curving streams are confirmed by other observers, and by the unerring eye of the camera (which has not as yet given us any trace of the nebulous light of even the brighter parts of the Milky Way) we shall not be able to resist the conclusion that the nebulous streams are associated with, and are not more distant than, the bright stars which lie upon them; and that associated with the Galaxy there are streams of opaque matter, dust clouds or fog-filled space, which cut out the light of the bright streams, and in most cases follow their curvings, so as to lie upon the central parts of the bright streams. A supposition which seems somewhat unlikely.

The production of these maps has occupied Dr. Boeddicker for the last five years. They have evidently been executed with extreme care. The accurate delineation of faint masses of nebulous light is a much more difficult and laborious task than would be supposed by those who have not attempted such work. The relative intensity of the various parts, as well as the shapes of the nebulous structures, have to be continually altered and compared under difficult conditions, and the ultimate result presented to the world generally only represents a small part of the work that has been done.

There can be no doubt as to the importance of the great problem which has been attacked by Dr. Boeddicker and the Earl of Rosse; but it is rather curious that the owner of the largest telescope in the world should have devoted so much of the time of his observatory to a class of work which can be done with the naked eye, and needs no instrument larger than an opera-glass. We shall see what the very numerous owners of such commonplace instruments have to say in confirmation or contradiction of the Parsonstown work. A. C. R.

SOME PROPERTIES OF NUMBERS.

By Robt. W. D. Christie.

IT is a fact well known to all who are engaged in the education of the young that the rule of arithmetic known as long division is one of the most difficult to be comprehended by learners; and it has occurred to me that an alternative method of arriving at the same results would be appreciated. The proposed method possesses one or two advantages peculiar to itself. The figures of the quotient are given in the reverse of the usual order, and, when the remainder is known, the quotient is obtained surprisingly quickly. The chief difficulty by this method is to obtain the true remainder, but this is by no means insuperable. I shall first give one or two examples having no remainder, and afterwards deal with the question of remainders. It is to be understood that the method particularly applies to all divisors ending in the digits 1, 3, 7, and 9, and therefore to all prime numbers, and consequently to any divisor whatever, since all numbers are compounded of prime numbers.

Example I.—Find the quotient of $86419753 \div 7$.

Rule.—Multiply both dividend and divisor by 3.

(N.B.—*Three* is the multiplier for all divisors ending in the digit 7. Multiplication is preferable but not absolutely necessary.)

Thus $259259259 \div 21$.

Now multiply this dividend by the tens' digit of the divisor, viz. 2, as follows, and point off the quotient.

25925925.9
18
90.7
14
57.6
12
24.5
10
91.4
8
58.3
6
25.2
4
2.1
2

The quotient required is thus 12345679.

Example II.—Again, find the quotient of

$2308576914 \div 17$.

Rule.—Multiply dividend and divisor by 3.

Thus $6925730742 \div 51$.

Now multiply this dividend by the tens' digit of the divisor, viz. 5, as follows, and point off the quotient as before.

692573074.2
10
306.4
20
728.6
30
569.8
40
252.9
45
920.7
35
688.5
25
66.3
15
5.1
5

The required quotient is 135798642.

Though the method is here given at full length, a good deal could, in actual practice, be done mentally. It will be noticed that the figures 69257, &c. are "brought

down" in the *reverse* of the usual order, *i.e.* from right to left instead of from left to right.

Example III.—Find the quotient of 733827160503÷743.

Rule.—Multiply all divisors ending in 3 by 7.

Thus we have 513679012352.1÷5201.

Now multiply by 520, and point off the answer as before.

513679012352.1
520
1183.2
1040
90014.3
1560
8845.4
2080
7676.5
2600
6507.6
3120
13338.7
3640
50969.8
4160
4680.9
4680

The quotient is 987654321.

It will be observed that there is here nothing "tentative," as in ordinary long division. In fact, the most difficult work required is multiplication by one figure, and I have no doubt that any intelligent child could be taught to find the quotient by this method much easier and more quickly than by the usual one.

Example IV.—Find the quotient of 41107567÷9001.

Rule.—Divisors ending in *unity* need no multiplier. Therefore × by 900.

411.0756.7
6300
410445.6
5400
40504.5
4500
3600.4
3600

The quotient is 4567.

Example V.—Find the quotient of 2929559÷389.

Rule.—Multiply divisors ending in 9 by 9.

Thus 26366031÷3501.

Now multiply by 350, and point off the quotient as before.

2636603.1
350
3625.3
1050
6257.5
1750
2450.7
2450

The required quotient is 7531.

I have now given all the varieties which will be required, viz. divisors ending in 1, 3, 7, or 9.

In a future paper I purpose, with your kind permission, giving a few further particulars showing the adaptability of the method to all divisors whatsoever.

COLOUR BLINDNESS.

By Richard Beynon.

THE first prominent case of colour blindness of which we have authentic record is that of John Dalton, the propounder of the Atomic theory. Although in his Lectures on Natural Philosophy he had discoursed on the "Doctrine of Colours," Dalton did not discover his own infirmity until a later date, and then quite by accident. The blooms of the geranium appeared to him a different colour by candle-light than by day. In spite of the assurances of his friends that the vivid red of the flowers was constant, to him the blooms were sky-blue by day and red by candle-light. From this discovery he was led to investigate the peculiarity of his own colour vision by means of the solar spectrum. As a result of his researches he clearly demonstrated that there are some people who experience the same sensation of colour from two such opposite colours as red and green. From the date of Dalton's discovery in 1794 down to a few years ago, very little light was thrown upon the apparent vagaries of this disease. It is true that several treatises were written on the subject, but they treated colour blindness rather as a rare and curious phenomenon than a malady which had any practical bearing upon the relations of every-day life. In the year 1877 public attention was directed in a very forcible manner to the practical issues hinging upon colour blindness. In the December of 1876 the railway accident commonly known as the Arsley Junction Disaster occurred, caused by the inability of a responsible person to discriminate between red and green signal lights; and then a series of letters and articles appeared in the *Times* drawing public attention to the great importance of this subject, and as a result the Board of Trade inaugurated compulsory tests for those engaged in the Mercantile Marine as to this visual defect. There seem to be three primary colour sensations which give rise to all other sensations of colour—these are red, green, and violet. The person who is not colour blind can perceive with the central portion of his retina all three of these colours. In a zone outside this, red is not seen; and in a zone outside of this again both red and green fail us, and we can perceive only blue or violet. Colour blindness is the failure of one or more of these three sensations. A person may be blind to red, to green, to violet, or to all three. The first two, however, involve each other, for a person blind to red is also blind to its complementary green. Blindness to violet includes blindness to yellow also, but this phase of the disease is very rare indeed. It must not be supposed, however, that a person blind to red sees green as a person possessed of normal vision does; he sees both red and green as greyish, and, in proportion as he is colour blind, all colours containing red and green will appear as if so much grey, or white and black mixed, had been used in producing the colour, instead of the ordinary red and green pigments. Colour-blind subjects instinctively and of necessity learn to judge of the colour of light by its intensity. Cases of total colour blindness, in which the person is devoid of all colour perception and sees coloured objects merely as shades of black and white, are exceedingly rare.

Examinations of males and females of all races and ages prove that about 3·5 of the former and 1·5 of the latter are afflicted with colour blindness.

Professor Holmgren, of Upsala, examined 32,165 men and found 1,019 or 3·16 per cent. colour blind. Of 18,556 men tested by Dr. Joy Jeffries, of Boston, Mass., 764 or 4·11 per cent. were colour blind.

The London Committee for investigating the prevalence

XUM

Distant View of the Lick Observatory, Mount Hamilton.

View from Mount Hamilton over Sea of Cloud.

Direct Photo Eng. Co., Limited, 9, Barnsbury Park, N.

of colour blindness found 617 colour-blind people, or 4·156 per cent., out of the 14,846 examined by them. Dr. Bickerton, among 3,087 men tested by him, discovered that 105 or 3·40 per cent. were suffering from this visual affliction.

The method of examination in all cases was that recommended by Professor Holmgren. It consists in each individual picking out from a large number of differently coloured wools all those skeins which have in them any tint of the particular test colour placed before him. The large majority of people would pick out to the very last every skein which had any tint of green in it, no matter how delicate; but a certain number would choose some colour, such as grey, yellow, or red, to match with the green, or they would omit to pick out the greens. In this manner their weakness of colour perception would betray itself to the examiners, who would then proceed to apply, under the same system, still more crucial tests. That colour-blind tests should be absolutely fair to the tested one, it is of the highest importance to distinctly observe the difference between the manner in which the colour-blind *sees* and the manner in which he *names* colours. The sensation is based upon the nature of the sense of colour in the organisation of the optic nerve from birth. The name, on the contrary, is learned. It is purely conventional, and depends upon exercise and habit. The names of colours are naturally the objective expression of subjective sensations. They are regulated by the system of the normal sight, and cannot, consequently, agree with that of the colour-blind. They can nevertheless be learned by the latter, and even applied correctly in many cases. It is no doubt under this veil that many colour-blind subjects unconsciously conceal their infirmity from themselves and their most intimate friends. Hardly any limit can be set to their capacity for learning other attributes of coloured objects, and of recognising and remembering their colour names through these alone. Thus they deceive themselves that they have gained by *practice* a colour perception they were not born with. Persons afflicted with colour blindness have been known to succeed as landscape and portrait painters; but then their colours must either be marked or chosen for them, or detection of their failing may ensue. A student of the Royal Academy who was selected, not only by the authorities, but also by his fellow-students, as having the best perception for form and power of light and shade, turned to the use of colours. In this branch of his art it was naturally supposed that he would also exhibit talent. He was allowed to take a portrait by Titian from the National Gallery, and have it in a small room by himself. There he copied it to the best of his ability, and, as he stated to the Principal and his brother students, no one visited him while he was at his work. His result was the most perfect copy, as far as light and shade went—but all shades of green had been used.

The consensus of medical opinion goes to prove that colour blindness is congenital and hereditary. Children born with it do not grow out of it as they rise in years, nor can the defect be palliated by any practice with colours. It has been shown that this visual defect is subject to the general laws that govern the transmission of hereditary disease from one generation to another. In the ordinary walks of life a man may go through life colour blind merely at the cost of inconvenience and discomfort to himself. But on the ocean and the railway, where safe locomotion is always dependent upon the ability of the look-out to discriminate immediately and correctly between red and green signal lights, every degree of chromatic defect is dangerous alike to life and property. But of this aspect of the colour-blind question and its close relation to the Mercantile Marine, I propose, if the Editor will permit, to write on a subsequent occasion.

Persons cannot be tested for colour blindness too early in life. The tests now employed are of such a simple character that they might with very great anvantage be introduced into our public schools; and many a lad would be spared the mortification of discovering in later life that he has embraced a calling continuance in which is fraught with terrible risk and danger to the lives and property entrusted to his care.

ON LARGE TELESCOPES.

By A. C. Ranyard.

IT is now more than two centuries and three quarters since the imagination of man was first stirred by the invention of an instrument which enabled him to magnify the face of the heavens. He had from a very early date—from Assyrian times at least—possessed lenses which enabled him to magnify the minute things about him to a small extent, and to see somewhat more of their beauty than he could detect with the eye alone. But the invention of the telescope in the first decade of the seventeenth century, or, more accurately, the use to which Galileo put the new-found treasure, revolutionized philosophy. It was a poor little instrument which Galileo possessed, giving very little light and a great deal of colour. Though his best telescopes magnified thirty-two or thirty-three times, the sharpness of their images must not be compared with a modern achromatic of similar power. Since the days of Galileo, it has been the constant ambition of many minds to devise means which would enable us to peer further into space. The progress was at first very slow, longer and longer telescopes were used, till instruments of over 200 feet focal length were employed; they had, of course, no tube. The object glass was pulled up and down the side of a mast, and the observer stood on the ground with the eye-piece held to his eye, and a string in his hand to turn the object glass towards him. Even in still weather such telescopes must have been very difficult to use with the constant varying height of the object above the horizon, and the shifting of the object glass and observer necessary to keep the object in focus. But with such an instrument (of 212½ feet focal length) Bradley measured the diameter of Venus in 1722; and Casini observed the great division in Saturn's ring, and four of his satellites. Titan, the largest of the satellites, had been discovered in 1655, with a 12-foot tube, by Huyghens.

The first material step in advance was due to the suggestion of a Scotchman, James Gregory, who, in his *Optica Promota*, published in 1663, proposed that the rays of light from a remote object should be received by a concave parabolic speculum and be reflected back by a smaller elliptic speculum through a hole in the centre of the larger reflector; but he failed in his attempt to obtain a sufficiently true parabolic figure. And the first person who actually succeeded in making a reflecting telescope was Sir Isaac Newton. Although this invention got rid of the chromatic difficulty (for rays of all colours are brought to the same focus by a reflector), very little astronomical work was accomplished with the new instrument of research until after the invention of the achromatic telescope, the idea of which had been conceived by Newton. But owing to a curious mistake in an experiment the cause of which is involved in mystery, he not only did not invent the achromatic telescope, but he went so far as to predict that such a telescope never could be

XUM

made. The great authority of Newton no doubt checked experiment in this direction for a generation, and the mistake is much to be regretted. In his *Optics*, Book I., Part II., Experiment 8. Newton says:—"I found, moreover, that when light goes out of air through glass, and thence goes out again into air, whether the refracting superficies be parallel or inclined to one another, that light as often as by contrary refractions 'tis so corrected that it emergeth in lines parallel to those in which it was incident, continues ever after to be white. But if the emergent rays be inclined to the incident, the whiteness of the emergent light will by degrees in passing on from the place of emergence, become tinged in its edges with colours. This I try'd by refracting light with prisms of glass placed within a prismatic vessel of water." From this Newton concluded that no combination of lenses of different refractive index would bring light to a focus without separating different colours of the spectrum in the same way as they are separated by a single lens.

It was not till 1729, two years after the death of Newton, that Mr. Chester Moor Hall, a young barrister of the Inner Temple, succeeded in combining two lenses of different sorts of glass so that they gave colourless images. It is known that he constructed several achromatic telescopes, one of two and a half inches aperture and only twenty inches focal length, which was in existence in 1790. But how he arrived at his invention, whether experimentally or deductively from experiments with prisms, is not known. No use of this new and important weapon for astronomical discovery was made for more than a quarter of a century, and the invention had been forgotten, or perhaps it was not ever known to any very wide circle. At all events, it cannot kave been known to the members of the Council of the Royal Society, who, thirty-two years after, in 1761, awarded medals, and distributed the patronage of English science. For they then gave the Copley Medal to John Dollond for a similar discovery, of which he had seen the commercial value, if not the astronomical use.

John Dollond was a Spitalfields weaver. He was born in 1706, and at the age of forty-six, having set up his son as an optician and joined him in the trade, he commenced experiments with prisms for the purpose of testing the truth of the statement of Newton quoted above. Having found that Newton was mistaken, he set himself to combine suitable lenses of different refractive index, and made an achromatic telescope. This is the story as given by Dollond himself in a paper published in the *Phil. Trans.* of the Royal Society. On the 19th of April 1858, he took out a patent for his invention, which eight years afterward was disputed in a Court of law; for the patent had become valuable, and other opticians, hearing of Moor Hall's discovery, had begun to pirate it. Champness, an optician in Cornhill, was proceeded against, and he brought workmen into court who proved to the satisfaction of Lord Mansfield that, twenty-five years previously, they had made similar instruments for Mr. Moor Hall. Lord Mansfield upheld the patent, remarking that "It was not for the person who locked up his invention in his scrutoire to profit by it, but he who brought it forth for the benefit of the public."

I hope that it will not be thought that I wish to throw any doubt on the genuineness of Dollond's discovery. I believe this to be one of the very numerous duplicate discoveries which may be quoted in the history of science. Their existence is almost as remarkable as the number of double stars, and the duplicity of so many lines in the spectrum—there must be some reason for it. It is not so strange a phenomenon when we regard a discovery as the last and most fruitful step in a chain of thoughts, many of which are the common property of the age in which the discoverer lives. We are too apt to look at discoveries as the sole production of one mind. That John Dollond was an independent thinker and worker is, I think, sufficiently proved by other things known about him. He is said to have died from a fit of apoplexy, brought on by intense application in studying Clairant's Theory of the Moon. From the time of Dollond onward the refracting telescope went on improving; but great strides were made, towards the end of the century, in the construction of reflecting telescopes, especially at the hands of Short and Sir William Herschel.

The reflecting telescope is, to a great extent, a creation of English growth. It has been the favourite instrument of English amateur astronomers. Sir William Herschel, Sir John Herschel, Lassell, the Earl of Rosse, Common, and Isaac Roberts have all most successfully used reflectors, and with the exception of Mr. Roberts they have all made their own instruments. Reflecting telescopes have not been received with such favour abroad, or even in America. With the exception of a 28-inch reflector, made by Dr. Henry Draper, no large reflectors have been used in America, and very few on the Continent of Europe. The reflecting form of telescope has been chosen by the great amateur astronomers (who have done so much towards the progress of astronomy), probably because it is less costly to make than a refractor of equal aperture, and there seems to be no limit to the size of the reflector except the mechanical difficulties involved in its construction, whereas with the refractor we are fast approaching the practical limit of size. If you double the diameter and focal length of a refractor you quadruple the amount of light that is lost by absorption in the object glass; thus the thickness of the crown glass lens of the great Washington 26-inch refractor at its centre is 1·88 inches, and the thickness of the flint-glass lens is 0·96 inches, making together a total thickness of glass of 2·87 inches. Even with the clearest glass manufactured, more than half the light which falls on such a thickness of glass is absorbed in passing through it. If we double the thickness, more than three-quarters of the light would be absorbed, and less than one quarter would be transmitted; for the first half of the thickness halves the light, and the second half halves it again. The greatest loss of light is only for the centre of the object glass; but in all parts the absorption is quadrupled for a lens of double aperture. It will thus be seen that we are rapidly advancing towards the limit where an increase of size with the refractor will not give us an increase of light. But with the reflector the whole of the light reflected reaches the eye-piece, whatever is the size of the instrument. The difficulties which set a limit to the size of the reflector are chiefly mechanical. If the aperture of an instrument is doubled, and the same proportions are kept, the weight of each part of the instrument is multiplied by eight. We have not yet approached the proportions of the Eiffel Tower, or the Forth Bridge; but it is not to such immense increases of size that I look for progress in our knowledge of the Universe. It is rather to the increased sensitiveness of photographic plates, and to improvements in the driving, accurate figuring, and mounting of telescopes. It has always been acknowledged that the most important part of an instrument was the man at the eye-piece end. And in this day of large instruments the relative importance of the man is becoming greater and greater.

The great variety as well as complication of the appliances which are now-a-days supplied to the Observer by the Engineer may be judged of by our Frontispiece of

the eye-piece and of the great Lick 36-inch refractor. As in the case of Galileo and Dollond, it is the man who makes use of the idea or the tool at his command who makes the greatest progress, and leaves the greatest legacy to mankind.

We owe the pictures of the Lick Observatory with which this article is illustrated to Mr. Barnham, who is now on his way to Trinidad to observe the eclipse of the sun.

BARNACLES.

By S. Heywood Seville.

AMONGST the curious myths which in the middle ages did duty for natural science, one of the longest-lived, and yet one of the most extraordinary, was that which not only conceived the common shell-fish the barnacle to be the fruit of a tree, but went on to allege its transformation into the sea-bird known as the barnacle goose. The successive changes from fruit to fish, and from fish to fowl, which the myth involved, proved no obstacle to its wide acceptance and long-continued credence. It was widely current before the end of the twelfth century. Giraldus Cambrensis, writing in the reign of Henry II., gives in his *Topographia Hiberniæ*, a detailed account of it. "There are in this place," says he in one passage, "many birds which are called Barnacles; against nature, nature produces them in a most extraordinary way. They are produced from fir timber, tossed along the sea, and are at first like gum. Afterwards, they hang down by their beaks as if from a sea-weed attached to the timber, surrounded by shells in order to grow more freely. Having thus, in process of time, been clothed with a strong coat of feathers, they either fall into the water or fly freely away into the air. They derive their food and growth from the sap of the weed or the sea by a secret and most wonderful process of alimentation. I have frequently with my own eyes seen more than a thousand of these same bodies of birds hanging down on the seashore from one piece of timber, enclosed in shells and already formed. They do not breed and lay eggs like other birds, nor do they ever hatch any eggs, nor do they seem to build nests in any corner of the earth." After this account Giraldus proceeds to inveigh against the custom, which prevailed in some parts of Ireland, of eating the barnacle geese during Lent—a custom which was justified by those who followed it by the argument that the geese were "not flesh nor born of flesh," and which affords striking proof of the credence accorded to the story.

Though contradicted from time to time by some of the bolder writers and observers, the fable kept a strong hold on the popular mind, and even the educated were not ashamed to avow their belief in it. Sir John Maundevile alludes to it in his *Travels*, where he speaks of the "trees that bear a fruit that becomes flying birds." Sir John somewhat naively adds that the people "towards Upper India," to whom he recounted the story, "had thereof great marvel that some of them thought it was an impossibility." The *Travels* appeared about 1370, and more than two centuries later the subject was treated with considerable fulness and in the most obvious good faith by John Gerarde, who, in his *Herbal*, published in 1597, devotes to it a chapter entitled "Of the Goose-tree, Barnakle-tree, or the tree bearing Geese," in which, after narrating the current belief as to the barnacle geese being produced in the North of Scotland from shell-fish growing on trees, he proceeds to pledge his own credit as to the main facts of the story. Clearly, the myth was current in Shakespeare's time, and, although in an edition of the *Herbal*, published in 1636, the editor added a note of caution to the reader at the foot of the chapter, yet eighty years after Gerarde wrote, a scientific writer was to be found, who, writing for scientific readers, asserted, of his own knowledge, the existence of the birds within the shells. This was Sir Robert Moray, who describes himself as "lately one of His Majesty's council for the Kingdom of Scotland," and who contributed to the *Philosophical Transactions* of 1677-78 a paper entitled "A Relation Concerning Barnacles," from which the following passages are transacted:—"Being in the Island of East, I saw lying upon the shore a cut of a large fir-tree, of about 2½ foot diameter and 9 or 10 foot long, which had lain so long out of the water that it was very dry; and most of the shells that had formerly covered it were worn or rubbed off. Only on the parts that lay next the ground there still hung multitudes of little shells, having within them little birds perfectly shaped. . . . The shells hang on the tree by a neck longer than the shell; of a kind of filmy substance, round and hollow, and creased, not unlike the windpipe of a chicken, spreading out broadest where it is fastened to the tree, from which it seems to draw and convey the matter which serves for the growth and vegetation of the shell, and the little bird within it. . . . This bird in every shell that I opened, as well the least as the biggest, I found so curiously and completely formed that there appeared nothing wanting as to the internal parts for making up a perfect sea-fowl; every little part appearing so distinctly that the whole looked like a large bird seen through a concave or diminishing glass, colour and feature being everywhere so clear and neat. The little bill like that of a goose, the eyes marked, the head, neck, breast, wings, tail, and feet formed, the feathers everywhere perfectly shaped and blackish coloured, and the feet like those of other water-fowl to my best remembrance."

Such was the old belief existing during five centuries at any rate, and probably accepted at periods both earlier and later than those from which the preceding examples are taken. To modern observers it seems utterly absurd. Science has shown its absolute groundlessness as natural history, and Professor Max Müller, to complete the rout, has put forward in his "Lectures on the Science of Language," a very interesting theory of its probable origin from the point of view of philology. But the latest researches have shown that the barnacle has been deposed from his place in a mythical metamorphosis only to take part in his life-history as now ascertained in another transformation scene quite as wonderful, and this time vouched by the careful observations of our best naturalists.

In the adult state the barnacle consists of a shell-fish permanently attached by a fleshy peduncle or stalk to a piece of timber or rock or some other object in the sea. The shell opens by a peculiar valve-like arrangement, and, through the aperture thus formed, several pairs of long, many-jointed "cirri" or feelers are put forth, which, by their constant waving motion, whirl to the creature's mouth the small particles which form its food. Huxley's description is concise and expressive: "A crustacean fixed by its head, and kicking the food into its mouth with its legs." It is not the change of this creature into a goose that science can now surprise us with; that story must be given up along with the accounts of griffins, phœnixes, and dragons. The fruit theory as to its origin must also be abandoned, but though the new account does not involve quite so violent a transition as that from the vege-

XUM

table to the animal kingdom, it is still in the steps by which the adult form is reached that those changes are revealed which almost entitle the barnacle to the reputation for facile metamorphosis with which our forefathers credited it. The steps in question are (besides the egg) the two stages know respectively as the *Nauplius* and *Cypris* stages. Immediately on its escape from the egg the young barnacle appears as an animal of microscopic size, active and free-swimming, equipped with a broad shell or shield on its back, and having three pairs of legs, a single eye, a mouth and a forked tail. This is the *Nauplius*, and in outward appearance the young creature exhibits at this stage no single point of resemblance to the parent form. It feeds and grows apace, and moults several times. It then enters the next condition of its existence—the *Cypris* stage. The broad shield-shaped carapace becomes folded together, somewhat after the pattern of a bivalved shell, and almost encloses its owner. The foremost limbs are transformed into a very peculiar pair of suctorial or adherent feelers, and the two hinder pairs are cast off, their place being taken by *six* pairs of powerful swimming-legs with bifid extremities. A pair of compound eyes is another new feature of this stage, and altogether the *Cypris*, while still quite distinct from the adult barnacle, presents a very different appearance from the *Nauplius*. The mouth is wanting, or at least is functionless, being covered by an integument without aperture. Existence in this stage is therefore necessarily short, and the *Cypris* soon fixes upon its future abode by attaching itself by its suctorial feelers to some piece of drift-wood, pile, or rock. A kind of cement, which it secretes by means of special glands, pours out round the base of attachment and quickly hardens, gluing the ends of the feelers firmly to the surface on which they rest. The compound eyes are shortly afterwards moulted; the body straightens out, and the shell thus comes to stand almost perpendicularly to the surface of attachment. Other changes follow: the shape of the shell is modified, and the position of the animal within alters in such a manner that the under surface of its body is turned directly away from the point of attachment; the integument covering the mouth is cast off; the legs cease all swimming ambulatory functions, and soon become mere cirri sweeping the water for prey; the feelers are gradually covered with a fleshy pulp, and, losing all trace of their old form, are converted into a single stalk of attachment; the new parts of the shell which are to form the valvular opening and other protecting plates begin to form, and, for all practical purposes, the barnacle, though still very minute, has attained its adult form, future development being mainly in the matter of size.

The old legend involved a double change from fruit to fish, and from fish to bird; the new history also deals with a double change, from *Nauplius* to *Cypris*, and from *Cypris* to barnacle. For one series of wonders another has been substituted, and, if this is not sufficient to restrain us from too hastily condemning our forefathers' credulity, it will be well to remember how recently we have arrived at the truth. Little more than fifty years ago the position of the barnacle in the animal kingdom was still completely unsettled. Agreeing in most of its outward characteristics with the mollusca, it was commonly classed with them. The *Nauplius* and *Cypris* were not connected with the parent form, but, if described at all, were treated as distinct animals. In 1830 J. Vaughan Thompson's description of his observations of their metamorphoses cast a new light on the subject, but the question still remained somewhat open ground for naturalists, and it was not until 1851–53 that Darwin, in his *Monograph of the Cirripedia*, definitely settled the barnacle's claim to be classed with the crustacea, and established beyond dispute the facts of its complicated and peculiar life-history.

Dr. Huggins has recently succeeded in obtaining a satisfactory photograph of the spectrum of Saturn and its rings. He states that the exact correspondence of the Frannhofer lines in the spectrum of the sky (*i.e.* in the solar spectrum), and in the spectrum of the body of the planet and its rings, is clearly shown. He is unable to detect any lines, either bright or dark, which are not present in the solar spectrum. He has obtained a similar result with the spectrum of Uranus.

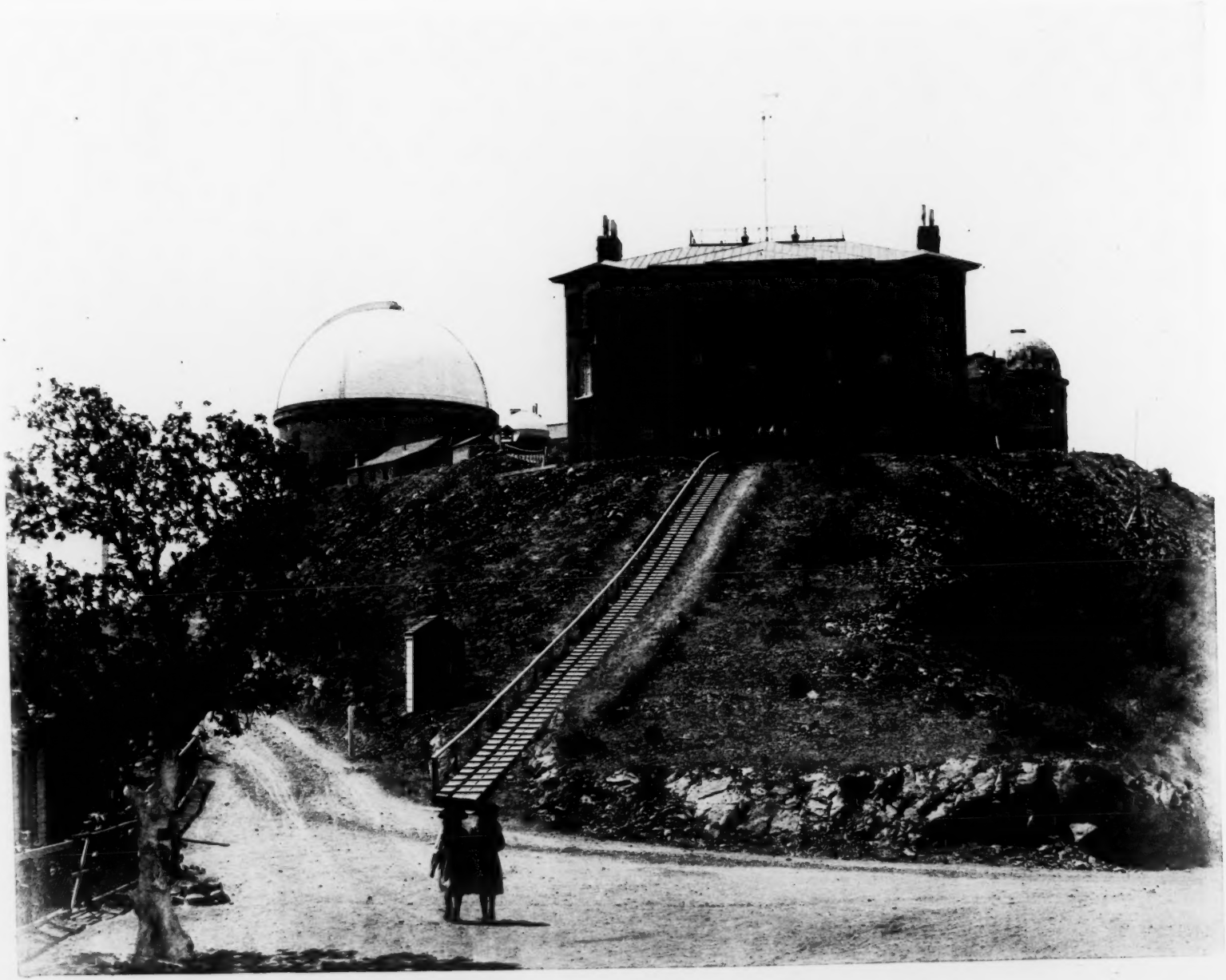
A memoir of Dr. Henry Draper has just been published by his friend, Prof. G. F. Barker.

Notices of Books.

A Text-Book of General Astronomy. By Chas. A. Young, Ph.D., LL.D., Professor of Astronomy in the College of New Jersey. (Boston, U.S.A., and London: Ginn & Co.) —A second edition of this valuable book has been called for within six months of the publication of the first edition. To call it a text-book is almost misleading. It is rather an encyclopœdia than a text-book, for it contains information on a very wide range of subjects connected with physical, as well as general, astronomy, arranged in numbered paragraphs under well-chosen headlines, and the whole is referred to by a copious index. Many of these paragraphs are admirable specimens of condensation, but the art of abbreviation has not been carried too far; the explanations remain lucid, and adapted, as Prof. Young desires they should be, to the comprehension of any "liberally educated person"; they require, in fact, a knowledge of elementary algebra, geometry, and trigonometry. It is refreshing to find such a liberal use of the term "liberally educated." On this side of the Atlantic the phrase "a liberal education," as well as the terms "scholar" and "a man of scholarship," only convey to most minds an idea of classical erudition; but we are, perhaps, a little in advance of the language we use. Prof. Young's book ought certainly to be understood by an intelligent school-boy. It would be impossible to treat so large a subject without making some statements which might be criticised, and without laying oneself open to the charge of having dealt with many subjects which are of less importance than others that have been omitted.

Prof. Young has treated his own especial subject, the sun, very meagrely. The polarised condition of the light of the corona is not referred to. The remarkable connection between the general form of the corona and the development of sun spots is not noticed, nor is the remarkable bending together of coronal structures into groups referred to. Only one picture of a corona is given, and that is wrongly oriented. It has its north pole where its eastern equatorial region ought to be. Curiously, the same mistake is made with regard to the same picture in the last edition of *Chambers' Handbook of Astronomy*, p. 486. Probably both mistakes are due to a mistaken orientation of a woodcut in an early number of Knowledge, which was one of the first pictures of a photograph of the corona taken during the eclipse of 1882 that was published. According to it, the comet "Tewfic," which was seen near to the sun during the Egyptian eclipse, was moving in an easterly direction, instead of northward, nearly at right angles to the ecliptic.

Prof. Young estimates the growth of the earth, due to



DOME OF THE GREAT EQUATORIAL OF THE LICK OBSERVATORY, AND OBSERVER'S HOUSE.

the fall of meteoric debris, as amounting to a layer of only about an inch thick in a thousand million years, an amount which may be practically neglected in considering geological and physical problems. His estimate is founded on Prof. Newton's well-known estimate of the average number of visible meteors which fall daily over the whole surface of the earth, but this leaves out of consideration telescopic meteors, and meteoric dust, which may fall without even being visible in the telescope. The number of telescopic meteors must be enormous compared with the number of visible meteors; for no one can observe for many hours, with a low power and a field 10′ or 15′ in diameter, without seeing several of them flash across the field. Prof. Young's assumption with respect to the average weight of luminous meteors is founded on some observations by Thomson, of Copenhagen (made thirty years ago), which connect the luminous energy of a standard candle with foot pounds. The assumptions which it is necessary to make in order to connect the momentum of a meteor with the light it gives out, as it is broken up by impact with the earth's atmosphere, are necessarily very wide. Probably a better idea as to the size of a meteoric particle capable of giving the light of a sixth magnitude star may be derived from the consideration that a standard candle, seen at the distance of a mile, is only a little brighter than a first magnitude star. Consequently, without taking atmospheric absorption into account, an incandescent body, at a distance of 100 miles, would only appear as a sixth magnitude star if it shone with a light about equal to that of an electric lamp of 100 candles power. As only the larger meteors enter the earth's atmosphere to a depth of below 70 miles above the surface, it may be assumed that few of the meteors seen, except those which appear near to the zenith, are within 100 miles of the observer. One may, consequently, pretty safely assume that a meteor which is just visible to the naked eye is larger than the portion of the carbons rendered incandescent in an arc light capable of giving 100 candles' power. For a mass of carbon, such as is used for electric lighting purposes, gives off more light while being driven into vapour than other substances which have been experimented upon; and the carbon of the electric light is not exposed to the tremendous bombardment of cold air, which must tend greatly to accelerate the disintegration of the meteoric masses in their passage through the air, as well as to cool their surface by removing the incandescent matter as rapidly as it is formed. Added to this, Prof. Newton's estimate of the average number of visible meteors which fall in a day, is made on the assumption that an observer at any station can see meteors which fall at a distance of 300 miles.

It would be an advantage if in future editions Professor Young would give more references to the places where the original papers referred to may be found. In many instances it is difficult, with the aid of the Royal Society Catalogue, to trace the memoirs referred to, and in the case of many investigations by American observers it is impossible from the mere name of the author to trace the paper referred to. The book is well illustrated, and in most instances the diagrams are original and well contrived. With all the advances that America has made, authors have more to contend with in the land of Franklin then they have here. The number of printer's errors must have been very annoying to Professor Young. This has, however, been greatly improved in the second edition.

Professor Young is an accomplished practical astronomer, and a teacher of great experience, as well as a popular exponent of science in lucid and simple language. He is also a man of wide reading, and the combination has given us an astronomical text-book of exceptional value.

A Hand-book of Descriptive and Practical Astronomy. By George F. Chambers, F.R.A.S., Barrister-at-Law, &c. &c. (Printed at the Clarendon Press, Oxford, 1889.)—We have received the first instalment of a Fourth Edition of this useful hand-book, which has now so grown in bulk that it will occupy three large octavo volumes, which will be sold separately. The first volume now published is devoted to the Sun, the Planets, and Comets. The second volume, which it is hoped will be published at the end of this year, will be devoted to "Instruments and Practical Astronomy"; and the third, which will probably appear in 1890, will refer to the Stars and Nebulæ. The valuable chapters on comets and the list of cometary orbits and other cometary statistics given in former editions have been brought up to date, and materially enlarged and improved upon. There is no other work published in England which contains so many cometary statistics and so much information with respect to the forms of cometary envelopes and jets. The chapters on meteoric astronomy and aërolites have been revised by Mr. Denning, and will well repay careful perusal. In the chapter on total solar eclipses, Mr. Chambers has reprinted the most important parts of Mr. W. H. Wesley's valuable paper on the structure corona, which was first published in the *Monthly Notices*. Mr. Wesley has brought the review of coronal photographs up to date for Mr. Chambers, and has given outline drawings of coronal photographs from 1851 to the eclipse of 1887. This affords a wider field for comparison than has hitherto been laid before the public.

The Story of a Tinder-Box. By Chas. Meymott Tidy, M.D., M.S., F.C.S., &c. (Society for Promoting Christian Knowledge. 1889.) This is a delightful little book, written in the plainest untechnical language. It is stated to be a reprint of holiday lectures delivered to young people (evidently at the Royal Institution, though the place of delivery is not mentioned). The book contains a great deal of information with respect to the history of matches, tinder boxes, flints and steels, Davy lamps, and such common things. Dr. Tidy seems to have been very fortunate in bringing together for his audiences a collection of tinder-boxes, old "Sulphur matches," "Chemical matches," which were invented in 1807; they were tipped with a mixture of chlorate of potash and sugar, and were fired by dipping them in a bottle containing asbestos moistened with sulphuric acid. The original "Lucifers," invented in 1826, which were tipped with a mixture of chlorate of potash and sulphide of antimony, and were lighted by drawing them through a little piece of folded glass paper; "Prometheans," and other early forms of matches. The tinder-box, however, seems to have held its own till 1833, when it was discovered that bones could be made to yield large quantities of phosphorus at a cheap rate. Up to that time phosphorus (which had been discovered more than a century and a half previously) had been sold at 50s. an ounce. The phosphorus match immediately came into general use, and the reign of the tinder-box ceased about four years before the reign of Queen Victoria began.

Timber and Some of its Diseases. By H. Marshall Ward, F.R.S. (Macmillan & Co.)—About eighteen months ago Prof. Marshall Ward contributed to *Nature* a series of articles on certain diseases of timber produced by parasitic fungi, and these have been expanded into the present volume of some 280 pp. The book practically consists of two parts, the first treating of the structure and classification of timber and the method of its formation and growth, and the second dealing specially with fungoid parasites by

XUM

which both living and dead wood are attacked, probably to a much larger extent than is generally imagined. The subject is one so new to the English reader, and yet so intrinsically important, and one withal which raises so many interesting biological questions, that this masterly exposition of it cannot fail to be welcomed as one of the most valuable additions to recent popular scientific literature. The chief facts connected with the microscopical structure of the different parts of a tree-trunk are dealt with in two explanatory chapters (one on the wood, the other on the cortex and bark) in so remarkably lucid a manner that no one need plead the scantiness of his botanical knowledge as an excuse for not reading the book. The woodcuts are both numerous and excellent, and several of them represent specimens from the classical series prepared by Prof. Hartig for the Museum of Forestry at Munich, an institution lately visited by the author. A long and rather difficult chapter has been added on the perplexing question of the cause of the ascent of sap in tall trees, and gives, for the first time in an English work, an epitome of the various modern theories on the subject, together with an account of the progress of the controversy during the last thirty years. As a good knowledge of the fundamental laws of physics is requisite for the mastery of this chapter, it will probably present difficulties to the general reader; but, as it is quite complete in itself, it may be passed over by those who desire to do so, without detriment to the rest of the work. In connection with the diseases of timber the main point emphasised by the author is "the destructive action of mycelia of various fungi, which, by means of their powers of pervading the cells and vessels of the wood, and of secreting soluble ferments which break down the structure of the timber, render the latter diseased and unfit for use." The chapter on "dry rot" deserves the closest attention of all who have any responsibility in connection with house property, and the warning held out concerning the danger of leaving the cut base of a branch on a growing tree exposed to the attacks of micro-fungi, claims thoughtful consideration on the part of all who are interested in forestry.

Harvey on the Circulation of the Blood. Edited by Alex. Bowie, M.D. (George Bell & Sons.)—The depths of error and misconception which existed at the commencement of the seventeenth century as to the functions of the heart, and from which William Harvey did so much to rescue medical science, together with the means by which he arrived at his splendid generalisation, have hitherto been known only to the few, and therefore the publishers of "Bohn's Select Library" have done well to add this volume to their series, thus rendering easily accessible to the public the details of that great discovery. The reader is here presented with a translation of Harvey's original Latin treatise "On the Motion of the Heart and Blood in Animals," and of his two "Disquisitions on the Circulation of the Blood," addressed to Riolan of Paris, in answer to objections. The translation is a revision of Willis's edition, published forty years ago under the auspices of the Sydenham Society. To this Dr. Bowie has prefixed an interesting biographical notice of the "simple, modest" little professor, the announcement of whose discovery so startled the world of his day that twenty years afterwards he was able to exclaim, "Scarcely a day, scarcely an hour has passed since the birthday of the Circulation of the Blood that I have not heard something for good or for evil said of this my discovery." At a time when the authority of the ancients was still paramount, and "the divine Galen" was venerated as an oracle, it needed no little hardihood to give to the world a book so revolutionary in its ideas, and even the prestige of his position as Court physician did not avail to protect the author from detraction, for he is himself reported to have said that, "After his book came out, he fell mightily in his practice; 'twas believed by the vulgar that he was crackbrained, and all the physicians were against him." Believing that the intimate connection of the heart with the lungs in the human subject was one of the chief causes of the prevalent misconceptions of the functions of those organs, he condemned strongly those anatomists who "confine their researches to the human body alone, and that when it is dead." He was thus led to pay great attention to comparative anatomy, expecting by the dissection of other animals in which the organs are placed in different relative positions to get at the truth, and this notwithstanding the sneers of those "who derided the introduction of frogs and serpents, flies, and others of the lower animals upon the scene, as a piece of puerile levity." How fully he was convinced of the supreme value of the experimental and inductive method is evident throughout; the most advanced scientist of the present day could not express himself more strongly than this: "I profess both to learn and to teach anatomy, not from books, but from dissections"; or again, "Our first duty is to inquire whether the thing exists, before asking why it exists." By acting on such principles he was able to demonstrate that the heart was the great propeller of the blood instead of the "generator of vital spirits and of heat," and that the veins and arteries were equally portions of the route taken by the whole of the blood in its circular course through the body, instead of being intended, the former to contain most of the blood, and the latter only a little, and that mixed with air and "vital spirits." Enough has, it is hoped, been said to show that this book contains much that is of interest, not merely to the technologist, but to any and every one who cares to inquire into the history of the conquests of science.

The Zoo. Second Series. By the Rev. J. G. Wood. (Society for Promoting Christian Knowledge.)—A capital book for children. It is admirably arranged with letterpress and illustrations judiciously combined, so that every page contains a picture, either plain or tinted. As these are by Harrison Weir, and many of them represent spirited scenes in animal life, there is no chance of the young people's interest flagging. The present series illustrates the Weasel family, Seals, Rodents, and Oxen, and the descriptions, by the late Rev. J. G. Wood, contain just the sort of information children delight in.

How to Teach Arithmetic. By T. J. Livesey. (Moffatt & Paige.)—This little book consists of a series of notes of elementary lessons on Arithmetic, from Numeration and the use of the Abacus to Proportion and some of its more important applications, intended to show the teacher how to lead his pupils to a comprehension of the *rationale* of the various "rules." The fact that it has reached its ninth edition seems to indicate that it has been found useful by many persons, chiefly, it may be presumed, amongst the ranks of junior pupil teachers. The methods advocated are sound, and if the book has a fault, it lies in prolixity, and in the fact that so very little is left for the intelligence of the teacher himself to supply.

The Rotifera, or Wheel Animalcules. (Supplement.) By C. T. Hudson, LL.D., F.R.S., assisted by P. H. Gosse, F.R.S. (Longmans, Green and Co.).—The present issue forms the completion of a most laborious task. Dr. Hudson's great work was originally intended to contain in two volumes descriptions of the Rotifera of the whole

world, so far as at present known, but during its progress the British material accumulated to so great an extent that it became necessary to omit the greater number of the foreign species. These are briefly described in the present supplement together with all the new British species which have been discovered during the last three years—that is, since the issue of the main body of the work. Thus the future student of this group has the great advantage of having the results of preceding investigations incorporated in a single book of reference. While regarding with great satisfaction the successful completion of so great an undertaking, we cannot but share the regret expressed by Dr. Hudson that Mr. Gosse, whose name will probably be always more closely associated with these wonderful little creatures than with any other forms of aquatic life, did not live to see the completion of an enterprise that occupied so much of his thoughts. That his work did not slacken towards the close of his life is evident from the fact that no less than sixty of the species here described are new British forms discovered by himself. Four beautifully executed, double-page plates, from drawings by the author and his late colleague, contain representations of about 150 species, or almost all that are included in the supplement. The descriptions are frequently accompanied with interesting notes as to the habits and movements of the animals. Special interest attaches to two species of *Calladina* here included, on account of the strangeness of their habitat, which is upon the leaves of *Jungermannia*, growing on the trunks of trees, the needful supply of water being obtained from the raindrops which trickle down the furrows of the bark.

Reports on Elementary Schools. 1852–1882. By MATTHEW ARNOLD. London: Macmillan & Co. 1889.—During the thirty-five years that Mr. Matthew Arnold was an Inspector of Schools, successive Administrations never troubled to ask whether he was not being employed in work which might well have been committed to men of coarser fibre instead of his wide experience being utilised in administrative educational reform. If the author of *Empedocles on Etna* and *Thyrsis* brought little zeal to the examination of needlework and the great problem as to the best kind of desks, he brought conscientiousness into the round of duty and made his reports vehicles of wise suggestion and penetrating criticism. Some of his recommendations have borne fruit; much that he sought to improve remains unaltered, nor will there be much approach made to his ideal of "an aim to train generally all who are born men to all which is human," while the system of "cram" and of payment by results is rampant. That grave defect, initiated by the Revised Code of 1881, it is hoped the New Code of 1889 will tend to abolish. In the note with which Sir Francis Sandford, to whom our thanks are due for rescuing the more important of Mr. Arnold's reports from the oblivion of H.M. Stationery Office, prefaces this volume, a becoming tribute is paid to the lamented author's work, the results of which "are written in much of our past educational history, and in the present working of our schools." What words of wisdom, what incisive touch of defects in home as in school training, lie scattered through this book, the following extract from the report for 1852, the year after Mr. Arnold's appointment, will exemplify:—

> I am convinced there is no class of children so indulged, so generally brought up (at home at least) without discipline—that is, without habits of respect, exact obedience, and self-control—as the children of the lower middle class in this country. The children of very poor parents receive a kind of rude discipline from circumstances, if not from their parents; children of the upper classes are generally brought up in habits of regular obedience, because these classes are sufficiently enlightened to know of what benefit such a training is to the children themselves; but children of the class I am alluding to receive no discipline from circumstances, for they are brought up amid comparative abundance; they receive none from their parents, who are only half-educated themselves, and can understand no kindness except complete indulgence; and, in consequence, nowhere have I seen such insubordination, such wilfulness, and such a total want of respect for their parents and teachers, as among these children.

In the same report, speaking of pupil teachers, he refers to "the utter disproportion between the great amount of positive information and the low degree of mental culture and intelligence which they exhibit." In conjunction with this notice should be given to a useful Report on Commercial Education, which was presented some two years ago to the Associated Chambers of Commerce. Although it urges reform in our present miserably abortive system chiefly on the ground that we should be driven out of the world's markets by our better-trained rivals abroad, the taking of this lower level at starting is necessary, since what is taught at school should be designed to best fit a youth for the battle of life. "We must all either work or steal," as Carlyle says. Exercises in rapid calculations, their application to business transactions, a general knowledge of books used in the counting-house, a familiarity with the atlas, a knowledge of French and German or Spanish, are not exclusive of studies which shall so elevate and humanise that the leisure which follows the day's work be not spent over the last sensational novel or in the degrading atmosphere of the music-hall. Certain it is—and "we speak that we do know"—that the majority of youths who offer themselves for business appointments, and on many of whom hundreds of pounds have been spent, are ill-equipped, knowing little, and careless about knowing much. They write badly; they cannot add up a column of figures correctly, and the answers which they give to the simplest questions in geography, and to such elementary questions as the size of the earth and the cause of day and night, equal in their painful drollery some of the famous examples in *English as She is Taught*.

E. CLODD.

Farm Live Stock of Great Britain. By PROF. ROBERT WALLACE, F.L.S., &c., Prof. of Agriculture and Rural Economy in the University of Edinburgh. (Oliver & Boyd. 1889.) This is a handbook of the different breeds of cattle, sheep, pigs, and horses found in the British Isles, with useful directions for their management in health and disease. No one interested—and who is not?—in farm animals, and the history of their improvement under scientific treatment, will fail to acknowledge a debt of gratitude to Prof. Wallace for his volume, with its numerous very beautiful photographic illustrations, which one might at first mistake for steel engravings. Prof. Wallace has, by a new process of photographic reproduction, presented us with a series of truthful portraits of representative prize-winners in the leading classes of show animals. They are not all equally good from an artistic point of view, as the facilities for photographing animals at our public exhibitions are not what they might be, if the importance of keeping such a register were recognised by the judges. We are, however, provided in Prof. Wallace's volume with a gallery of the most interesting and instructive character, by which a comparison can be instituted between the points of the principal breeds. The author has aimed at condensation throughout—as was indeed needed in such an extensive subject—but we should have been glad if he could have spared us a little farther space for the historical part of his subject.

A list of the most important herds of each breed might also be added, with advantage, to the next edition.

XUM

Primer of Cursive Shorthand. (The Cambridge System.) By H. L. CALLENDAR, M.A., Fellow of Trinity College, Cambridge. London: C. J. Clay & Sons, Ave Maria Lane. 1889. *Reading Practice. Facsimiles of Actual Writing.* By H. L. CALLENDAR, M.A., Fellow of Trinity College, Cambridge. London: C. J. Clay & Sons, Ave Maria Lane. 1889.—Mr. Callendar has followed up the publication of his "Cursive Shorthand," noticed in KNOWLEDGE for March, by the issue of a sixpenny Primer, and two threepenny Reading-books of eight pages each. These will be of assistance to the student. The reading-books are to be multiplied as occasion demands. In these days of shorthand competition Mr. Callendar does well to give to those learning his system advantages offered by other authors; though his methodical treatment of the subject will probably save him from the labour of compiling, and his students from the drudgery of studying, a Cursive Dictionary. For reporting scientific language with ease and accuracy, the systems that depend in practice upon consonantal skeletons are wholly inadequate. Only a joined vowel system, such as Mr. Callendar's is, can have any pretensions to deal effectively with technical terms.

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.].

MORE PROPERTIES OF NUMBERS.

To the Editor of KNOWLEDGE.

SIR,—I have just read, with considerable interest, Mr. T. B. Russell's letter on the above subject in the September number of KNOWLEDGE.

When the whole of the multiplication-table is dealt with on the lines which he suggests, and the result tabulated, the phenomena exhibited is very curious, and some of the peculiar properties of numbers still further demonstrated.

It will be remembered, by those who have read Mr. Russell's letter, that he introduces the subject by a reference to the well-known "property which is possessed by the integers of all multiples of 9, namely, that when they are added successively until only one figure remains, that figure will always be 9."

After applying the same process to three other numbers of the table—8, 5, and 6—Mr. Russell remarks that while none of them possess the same property as the number 9, "in each case some sort of order or progression was exhibited by the sums of the integers."

This "order or progression" is more marked when the process is applied to the whole table.

I reproduce his experiments with table 8 for reference:—

8×1		=	8
$8 \times 2 = 16$	$6 + 1$	=	7
$8 \times 3 = 24$	$2 + 4$	=	6
$8 \times 4 = 32$	$3 + 2$	=	5
$8 \times 5 = 40$	$4 + 0$	=	4
$8 \times 6 = 48$	$4 + 8 = 12$	$2 + 1 = 3$	
$8 \times 7 = 56$	$5 + 6 = 11$	$1 + 1 = 2$	
$8 \times 8 = 64$	$6 + 4 = 10$	$1 + 0 = 1$	
$8 \times 9 = 72$	$7 + 2$	=	9

and so on.

Beginning with the first number of the multiplication-table and applying the same process to the first eight consecutive numbers, and tabulating the result in each case, we get the variety of series placed in the *vertical* columns of the following table, under each number respectively.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	2	3	4	5	6	7	8	all nines.	same as table 1.	2.	3.	4.	5.	and so on.
2	4	6	8	1	3	5	7			,,	,,	,,	,,	
3	6	9	3	6	9	3	6							
4	8	3	7	2	6	1	5							
5	1	6	2	7	3	8	4							
6	3	9	6	3	9	6	3							
7	5	3	1	8	6	4	2							
8	7	6	5	4	3	2	1							
9	9	9	9	9	9	9	9							

If the process be applied to the next eight consecutive numbers of the table after 9, or to the eight consecutive numbers which follow any multiple of 9, the result will be a repetition of the same series in the same order, *ad infinitum*.

It follows, therefore, from this, that if the process be applied to consecutively higher *multiples* of any numbers in the above order the result will also be the same, *ad infinitum*.

The above table, therefore, exhibits the whole series of numbers which would be obtained by an application of the process to the entire multiplication table.

Let us note a few of its phenomena.

(*a*) The sum of each series is a multiple of 9. The integers of the sum of each series when added each make 9.

(*b*) The series in the first vertical column is the same as that in the first horizontal column. That in the second vertical the same as that in the second horizontal, and so on to the end of the table.

(*c*) The series in the vertical columns 1, 2, 3 and 4, are the same, *but in the reverse order*, as the series in columns 8, 7, 6 and 5 respectively, viz,, 1 and 8, 2 and 7, 3 and 6, 4 and 5.

(*d*) The series in column 10 (when produced) is the same as in column 1, 11 the same as 2, 12 the same as 3, and so on.

From (*c*) and (*d*) we can deduce two simple rules.

From (*c*) we note that any two numbers whose sum is 9 (or any multiple of 9) will produce the same series but in the reverse order; *e.g.*, $9^2 = 81$, $22 + 59 = 81$. Therefore if the process be applied to 22 times, and 59 times any eight consecutive numbers; they will each produce the same series but in the reverse order.

From (*d*) we note that if any of the numbers at the head of the table (higher than 9) be divided by 9, the *remainder* will indicate the column in which the series may be found which such number will produce; *e.g.*, $12 \div 9 = 1$, and 3 remainder, Therefore 12 times will give the same series as 3 times. Again, taking a much higher number, $78424 \div 9 = 8713$, and 7 remainder, Therefore 78424 times any 8 consecutive numbers to which the process is applied will produce the same series as 7 times. Any number which divides by 9 without a remainder will, of course, give the same result as 9.

I suppose all the above are explicable on the same lines,

Yours obediently,

WM. STANIFORTH.

Upperthorpe, Sheffield: Sept. 19th, 1889.

[I have to thank very numerous correspondents (26 in all) for letters on the above subject. Mr. Staniforth's letter, perhaps, puts the facts more concisely than any other. The fact that the sum of the digits of any multiple of 9 is itself a multiple of 9, may be made evident thus: With the decimal notation we use any number may be written as a series of powers of $(9+1)$ multiplied by digits; for example, 3591 may be thrown into the form—

$$3(9+1)^3 + 5(9+1)^2 + 9(9+1) + 1$$

When these binomials are multiplied out, every term will contain a 9, except the last of each—so that if the sum of the last terms, that is the sum of the digits, happens to be a multiple of 9, the whole number is so, and *vice versa*. It is evident that the series of numbers corresponding to the sums of the digits of successive multiples of 8 decreases by steps of one at a time; because, if we add 8 to any number we usually decrease the number in the integer place by 2, and add 1 to the number in the tens place, which decreases the sum of the digits by 1. Multiples of 8 never have a 1 in the last place, but the passing from 1 to 9 and from 0 to 8 is really a step backwards of 2 if we consider the figures to be written in a circle, or in an endless recurring series. Similarly the series of numbers corresponding to the sums of the digits of successive multiples of 7 decreases by steps of 2 at a time, and so on till we get to multiples of 4, when the step backward is 5 at a time, which with groups of 9 bring you to the same numbers as stepping forwards 4 at a time, and stepping backwards 6 at a time gives the same numbers as stepping forwards 3 at a time. Mr. Staniforth's square shows that the well-known 9 rule is only a particular case of a more general law, when the steps of the series are 0 at a time, and as you begin with 9 you never get any further. —A. C. Ranyard.]

DO VIPERS PROTECT THEIR YOUNG IN TIME OF DANGER BY SWALLOWING THEM?

To the Editor of Knowledge.

Sir,—There still seems considerable doubt among several of your correspondents concerning the correct answer to the above query. Will you allow me to relate my experience? When I was a lad between thirteen and fourteen years of age I started with a party of ten or a dozen boys from Chichester for Goodwood on a butterfly-catching expedition. We arrived on the downs, and, after very fair success in chasing and capturing insects, were fain to rest our tired limbs on a log which lay just on the outskirts of a plantation of pine trees. Boys that we were, we could not sit still very long, so began to roll the log as we sat on it. Just from under my part of the log out came an adder, making, if I remember rightly, a slight hissing noise, and followed by some five or six little vipers, I should think, of about one and a-half to two inches in length. The mother, as we took it to be, opened her mouth, and the little ones glided instantly into it and disappeared, as also did the mother, into the thick grass of the adjoining scrub.—I am, yours truly,

H. Combes.

Haverstock Hill Board School, N.W.

THE FACE OF THE SKY FOR NOVEMBER.

By Herbert Sadler, F.R.A.S.

THE increasing number of sunspots, though no very large ones have yet appeared, shows that the minimum is now fairly past. Conveniently observable minima of Algol take place on the 1st at 7h. 53m. P.M., on the 4th at 4h. 42m. P.M., on the 21st at 9h. 35m. P.M., and on the 24th at 6h. 24m. P.M. A minimum of λ Tauri occurs at 5h. 5m. P.M. on the evening of the 1st. In this star the change of light from normal brilliancy (3·4 magnitude) to minimum (4·2 magnitude) and back again takes a little more than 10 hours. Mercury is well situated for observation during the first three weeks of the month. On the 1st he rises at 4h. 58m. A.M., or just two hours before sunrise, having a southern declination of 6° 26′, and an apparent diameter of $6\frac{1}{2}''$. On the 19th he rises at 6h. 24m. A.M., or rather less than an hour before the sun. having a southern declination of 16° $\frac{1}{2}''$, and an apparent diameter of 5″. On the morning of the 10th he will be about $1\frac{1}{4}°$ *s.p.* the 4th magnitude star κ Virginis. During the month he passes from Virgo through Libra into Scorpio. Venus is a morning star, but is rapidly losing her brilliancy. On the 1st she rises at 4h. 18m. A.M. with a southern declination of 3° $\frac{3}{4}'$, and an apparent diameter of $11\frac{1}{4}''$; just $\frac{9}{10}$ths of the disc being illuminated. On the 30th she rises at 5h. 54m. A.M. with a southern declination of $16\frac{1}{4}°$, and an apparent diameter of $10\frac{1}{2}''$. On the morning of the 4th she will be about 8′ *s.p.* the $4\frac{1}{2}$ magnitude star θ Virginis. During the month she passes from Virgo into Libra. Mars is a morning star, but is not a very attractive object for amateurs, as his diameter at the end of the month only subtends $5\frac{1}{2}''$. On the 1st he rises at 2h. 36m. A.M., and on the 30th at 2h. 20m. A.M. He is in aphelion at 7h. A.M. on the 12th. On the morning of the 3rd he is about 50′ *s.p.* β Virginis. During the month he passes from Leo into Virgo. Jupiter must now be looked for very early in the evening near the SSW. horizon, if he is to be observed at all. On the 1st he sets at 7h. 30m. P.M., or three hours after sunset, with a southern declination of $23\frac{1}{2}°$, and an apparent diameter of 34″. On the 30th he sets at 6h. 3m. P.M., or two hours six minutes after sunset, with a southern declination of 23° 10′, and an apparent diameter of $32\frac{1}{4}''$. On the evening of the 13th he will be 14′ due north of the 6th magnitude star B.A.C. 6343. He is in Sagittarius throughout the month. The following three phenomena of the satellites occur between the times of the planet's being 8° above, and the sun's being 8° below, the horizon on the days named. On the 1st a transit egress of the shadow of the first satellite at 5h. 48m. P.M. On the 8th a transit ingress of the shadow of the first satellite at 5h. 25m. P.M., and on the 10th an eclipse (disappearance) of the third satellite at 5h. 40m. 47s. Saturn is a morning star, in Leo throughout the month. On the 1st he rises at 0h. 30m. A.M., having a northern declination of 11° 55′, and an apparent diameter of $15\frac{1}{3}''$. On the 30th he rises at 10h. 40m. P.M., having a northern declination of $11\frac{1}{2}°$, and an apparent diameter of $16\frac{1}{3}''$. Marth points out that on November 1st, at 8h. P.M., the satellite Japetus passes within 3″ of Titan, and shortly afterwards enters the shadow of the ring system, from which it emerges between 4h. and 5h. P.M. on November 2nd. Uranus is, for the purposes of the amateur, practically invisible. Neptune rises on the 1st at 5h. 36m. P.M., having a northern declination of $19\frac{1}{4}°$, and an apparent diameter of $2\frac{3}{4}''$, and shines as a dull 8th magnitude star. On the 30th he rises at 3h. 36m. P.M. He moves slowly to the west during November, and is in opposition to the sun on the 25th, when his distance from the earth is about 2,683 millions of miles. He is between ω (Omega) and 43 Tauri, gradually approaching the latter. November is a very favourable month for shooting stars. The most marked displays are the *Leonids* on November 13 and 14, the radiant point being in R.A. 10h. 0m. Decl. + 23°. The radiant point rises at about a quarter past ten P.M. The *Andromedes* occur on the 27th, the radiant point being in R.A. 1h. 40m. Decl. + 43°. The moon is full at 4h. 5m. P.M. on the 7th, enters her last quarter at 8h. 36m. P.M. on the 15th, is new at 1h. 44m. A.M. on the 23rd, and enters her first quarter at 5h. 29m. P.M. on the 29th. On the 3rd the $4\frac{1}{2}$ magnitude star 30 Piscium will disappear at 9h. 41m. P.M. at an angle of 132° from the vertex, and reappear at 10h. 55m. P.M. at an angle of 317° from the vertex, and

the same evening the 4½ magnitude star 38 Piscium will disappear at 11h. 50m. P.M. at an angle of 110° from the vertex, and reappear at 0h. 44m. A.M. on the 4th at an angle of 7° from the vertex. The same morning there will be a near approach of the 6th magnitude star B.A.C. 17 at 3h. 2m. A.M. at an angle of 63° from the vertex. On the 7th at 6h. 45m. P.M. the 6½ magnitude star B.A.C. 987 will disappear at an angle of 57° from the vertex, and reappear at 7h. 44m. P.M. at an angle of 275° from the vertex. On the 8th there will be a near approach of the 6th magnitude star B.A.C. 1272 at 11h. 23m. P.M. at an angle of 2° from the vertex. On the 11th the 6½ magnitude star 141 Tauri will disappear at 6h. 7m. A.M. at an angle of 103° from the vertex, and reappear at 7h. 8m. A.M. (four minutes before sunrise) at an angle of 340° from the vertex. On the 18th the 4th magnitude star ν Virginis will disappear at 2h. 4m. A.M. at an angle of 14° from the vertex, and reappear at 3h. 3m. A.M. at an angle of 225° from the vertex. On the 28th the 6½ magnitude star 29 Aquarii will disappear at 3h. 36m. P.M. at an angle of 177° from the vertex, and reappear at 9h. 29m. P.M. at an angle of 293° from the vertex. This is a pretty pair of 7 and 7¼ magnitude stars 3·7″ apart. On the 29th the 4th magnitude star τ^3 Aquarii will disappear at 3h. 48m. P.M. (six minutes before sunset) at an angle of 83° from the vertex, and reappear at 5h. 1m. P.M. at an angle of 292° from the vertex. This is an orange-coloured star, with a blue 9th magnitude companion at 132″ distance.

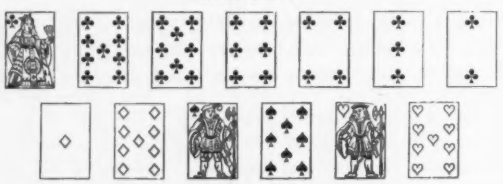
Whist Column.

By W. Montagu Gattie.

THE DISCARD FROM A WEAK SUIT.

THE following hand, which is contributed by Mr. H. F. Lowe, affords a simple illustration of the importance of the discard as a means of information. The player whose hand is exposed leads one of his long trumps in order to ascertain from his partner's discard which of two is his strong suit.

HAND NO. 6.

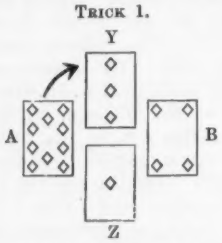


Z's Hand.

Score—Love All. Z turns up the four of clubs.

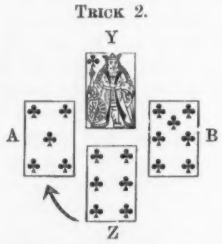
NOTE.—A and B are partners against Y and Z. A has the first lead; Z is the dealer. The card of the leader to each trick is indicated by an arrow.

TRICK 1.



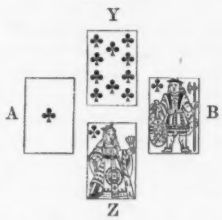
Tricks—AB, 0; YZ, 1.

TRICK 2.



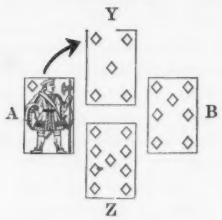
Tricks—AB, 0; YZ, 2

TRICK 3.



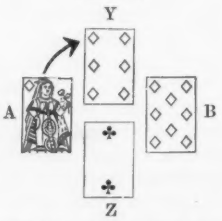
Tricks—AB, 1; YZ, 2.

TRICK 4.



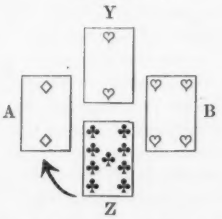
Tricks—AB, 2; YZ, 2.

TRICK 5.



Tricks—AB, 2; YZ, 3.

TRICK 6.

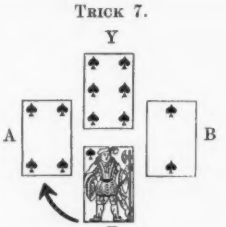


Tricks—AB, 2; YZ, 4.

NOTES.—*Trick* 5.—Scientifically speaking, it would be more accurate to trump with the nine, and then lead the two, thus showing conclusively that he has the three intermediate cards. It is true that Y should know this from Trick 2, for Z must have two trumps higher than the six (*i.e.* the eight and nine), and, A and B having played five and seven respectively, he must also hold the small ones; but there is never any harm in telling one's partner a thing twice over.

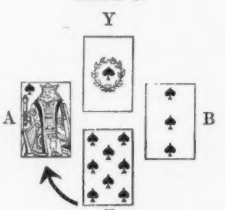
Trick 6.—This constitutes the point of the hand. Z has no means of knowing whether his partner's strength lies in spades or hearts. In order to win the game it is necessary to make all the remaining tricks, so that everything depends on Z's selecting the right suit. He therefore leads a trump in order that his partner's discard may guide him.

TRICK 7.



Tricks—AB, 2; YZ, 5.

TRICK 8.



Tricks—AB, 2; YZ, 6.

Tricks 9 *to* 13.—Y makes two more spades, on which Z discards his hearts, Z makes his three remaining trumps, and

YZ SCORE FIVE BY CARDS.

A's Hand.	B's Hand.
C.—Ace, 5.	C.—Kn, 7.
D.—Kg, Qn, Kn, 10, 2.	D.—8, 7, 4.
S.—Kg, 4.	S.—7, 5, 3, 2.
H.—Kg, 8, 6, 3.	H.—Ace, Qn, 10, 4.
Y's Hand.	**Z's Hand.**
C.—Kg, 10.	C.—Qn, 9, 8, 6, 4, 3, 2.
D.—6, 5, 3.	D.—Ace, 9.
S.—Ace, Qn, 10, 9, 6.	S.—Kn, 8.
H.—7, 5, 2.	H.—Kn, 9.

REMARKS.—*Tricks* 2 *and* 3.—After these tricks, as already pointed out, Y can place the remaining trumps in Z's hand.

It is worth noticing that, if Z had led his lowest, or even his penultimate, trump at Trick 2, Y could not have known where the eight and nine were until three tricks later.

Trick 4.—A's lead is in accordance with the American code, which provides that, when ten, led from king, queen, knave, ten, draws the ace, the original leader should continue with knave if he opened from a five-suit, and with queen if he opened from a four-suit. But, in the present instance, as A is playing a losing game, we should have preferred to continue with the king, so as to keep Z in the dark as long as possible as to the position of the queen. As the cards lie, it does not matter which of the three is led first.

Trick 5.—It may be urged that, since there is nothing to show that Y has not another trump, A, by going on with the diamonds, runs the risk of enabling him to make it separately. But this would, under the circumstances, be an advantage, since Y would then have to lead up to A in either spades or hearts.

Trick 7.—A plays correctly, we think, in passing the knave, for Z may not have another spade, and in that case, if the knave wins, will have sooner or later to lead a heart. This chance seems preferable to the chance of B's holding the ten twice guarded. Of course, if B holds either ace or queen of spades, A's play is immaterial.

Elementary Explanation of the Play.

Trick 1.—The ten is the proper lead from a suit headed by king, queen, knave, ten, or by king, knave, ten. B infers from this trick that Z has not the queen, but neither B nor Z can at present tell whether it is with A or Y. On the other hand, Y can place the queen with A, for if either of the others had held it he would have played it.

Tricks 2 *and* 3.—Z, of course, opens trumps; and Y, equally of course, returns them. The student should observe that Z, having led a low card, must have at least three better; and, therefore, after he has played the queen and the other high cards have fallen, he must hold the eight and nine, since these are the only two unplayed trumps higher than the six (his original lead). A and B, by playing the five and seven respectively, show each other that they have not the two or three (the four was the turn-up card), so that they know after Trick 3 that all the trumps are against them. But they cannot tell from Y's lead of the ten whether he has one of the small ones or not, for he would return the higher of two remaining cards.

It now appears that honours are "easy," and, therefore, the score being Love-all, YZ must make eleven out of the thirteen tricks in order to win the game.

Trick 4.—Clearly A can do no better than continue his winning diamonds.

Trick 5.—As a matter of fact, A would have saved the game at this point if he had led a heart; but it was, of course, quite impossible for him to know this, or to foresee that with king guarded in each of the other suits he would be unable to make another trick.

Trick 6.—Z has now drawn all the adverse trumps, and is in possession of the lead. He knows that diamonds are against him, but has no clue as to his partner's strength in the other two suits. His lead of a trump amounts to asking his partner the question, "What would you like me to lead?" Y replies by throwing away a heart, which means to say, "My strong suit, which I want you to help me to establish, is spades." This is confirmed by B, who, in accordance with the principle explained in our last article (see Knowledge, vol. xii., p. 254) discards from his best-protected (*i.e.* strongest) suit. It is practically certain, therefore, that whatever strength Y has is in spades.

Trick 7.—Z accordingly leads his best spade, so as to assist his partner as much as possible. Y finesses against the king, because this is the only possible way in which the game can be won.

Chess Column.

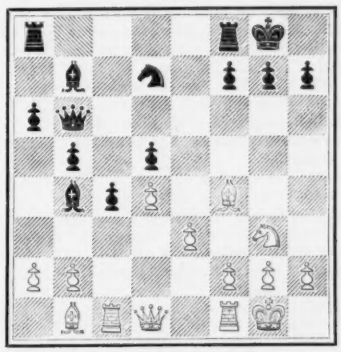
By I. Gunsberg (Mephisto).

[Contributions of general interest to chess-players are invited. Mr. Gunsberg will be pleased to give his opinion on any matter submitted for his decision.]

THE following interesting game was played in the Handicap Tournament at Simpson's Divan last month:—

White. F. J. Lee.	Black. O. C. Muller.	White. F. J. Lee.	Black. O. C. Muller.
1. P to Q4	P to Q4	9. B × P	P to QKt4
2. P to QB4	P to K3	10. B to Q3	P to B5
3. Kt to QB3	Kt to KB3	11. B to B2	B to Kt2 (*c*)
4. B to B4 (*a*)	B to Kt5	12. R to Bsq	QKt to Q2
5. P to K3	Castles	13. Kt to Kt3 (*d*)	Q to Kt3 (*e*)
6. B to Q3	P to QB4	14. B to Ktsq	Kt to QB (*f*)
7. Kt to K2	P to QR3	15. Kt × Kt	P × Kt
8. Castles (*b*)	P × BP		

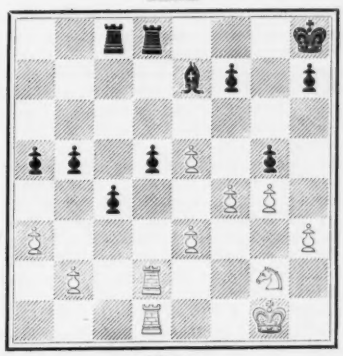
Black.



White.

16. Q to R5 (*g*)	P to Kt3	28. Q to Kt3	Q to K2
17. Q to R6 (*h*)	KR to Ksq	29. Kt to B4	KR to Q3
18. Q to R4	QR to Qsq	30. Kt to Kt2	K to Rsq
19. P to QR3 (*i*)	B to K2	31. Q to Q5 (ch) (*k*)	Q × Q
20. Q to R3	B to QBsq (*j*)	32. P × Q	R to K3
21. Kt to K2	Kt to B3	33. KR to Qsq	B to K2
22. Q to Kt3	Kt to R4	34. P to B4	P to Kt4!
23. Q to B3	B to B3	35. B to B5 (*l*)	R to QB3
24. P to KKt4	Kt × B	36. B × B	R (B3) × B
25. Kt × Kt	Q to Q3	37. R to B2	P to QR4
26. P to R3	B to Kt4	38. R (B2) to Q2	
27. Kt to K2	R to K3		

Black.



White.

WHITE. F. J. Lee.	BLACK. O. C. Muller.	WHITE. F. J. Lee.	BLACK. O. C. Muller.
	P to Kt5 (*m*)	43. Kt to Ksq (*n*)	P to B7
39. RP × P	RP × P	44. Kt × P	R × Kt
40. R × P	R × R	45. R to Q7	B to B4
41. R × R	P to B6 !	46. P × P	B × P (ch)
42. P × P	P × P	47. K to Bsq	K to Ktsq

And Black won.

NOTES.

(*a*) A move of doubtful value. If White wants to advance on the Queen's side he should leave the Bishop on Bsq; if, on the other hand, he wants to attack on the King's side, then the B on its own square would also be useful, or he might play B to Kt5

(*b*) White ought to have played P × BP, so as to provide against the advance of Black's Pawns on the Queen's side, prepared by Black's last move.

(*c*) Black has gained very important time, and has brought his Queen's Bishop, which otherwise would have been locked in, into very useful activity.

(*d*) White is, apparently, trying to prepare for an advance of his King's Pawn, but when that is done the Queen's Pawn becomes weak.

(*e*) The proper move, especially if he anticipates an advance in the centre; it makes the Queen more useful, and admits of QR to Qsq, if requisite.

(*f*) Black wants to force an exchange to block the centre, being content to rely on the superiority of the position of his Pawns on the Queen's side, for the End-game. We should have adopted a different course.

(*g*) The only effect of this move is to strengthen Black's position, for by playing P to Kt 3 he cuts off the possibility of an advance of the White Knight, and also prepares to place his King's Bishop into a more useful position by KR to Ksq, B to Bsq and B to Kt2, if necessary. White had a much better move in 16. Kt to B5, threatening 17. Kt × PK × Kt 18. Q to Kt4 recovering the piece. If in reply to 16. Kt to B5 Black plays P to Kt3, he may either fix his Knight on R6, or perhaps, better still, play 17. P to QR3.

(*h*) White has evidently lost hold of his game from an early stage; his moves are aimless.

(*i*) When there are two Pawns to 3 on the Queen's side, the Pawns are weaker if one is advanced to QR3.

(*j*) How that poor Queen has to suffer for the one indiscreet sixteenth move. She is now sorely pressed, and has none too many places to hide her guilty head out of sight of the vengeful Bishop's having evil designs of capturing her. Black is certainly handling his forces in an admirable manner.

(*k*) It was a mistake to exchange Queens here, because Black's position improves thereby on the Queen's side. He will soon force a passed Pawn.

(*l*) This Bishop has been absolutely useless to White all the game through.

(*m*) An ingenious move. Black is now reaping the advantage of his superiority of position on the Queen's side, which he had been consistently playing for from the very beginning of the game.

(*n*) He cannot stop the Pawn otherwise, for if 43. R to Qsq, P to B7, 44. R to Bsq, B to R6 wins.

TEACHING CHESS.

A Chess instructor now-a-days has rather a difficult task to perform. If he is of the modern school, he is brimful of new theories of the Openings (so he thinks), and he is overburdened—hackneyed with stereotyped notions of chessy wisdom, which he calls general principles. He has observed either in his own experience, or that of other players, that defence is easier than attack, that it pays wonderfully well to play a featureless and restrained game, and that it is unprofitable to venture on Gambits and the like. New discoveries in the Openings prove (to him) most of the formerly practise l lines of play to be unsafe. For, be it noted, your modern analyst only makes negative discoveries—he never originates anything. In fact, if he be a conscientious teacher, he should say to his pupils: My defensive philosophy consists in never risking anything, and principally in trying not to lose the game rather than trying to win it, and if he were to speak his mind freely, he would tell you that there are really but two reliable Openings, the Ruy Lopez (that "sheet anchor of dull mediocrity"), and the Irregular game. He knows of many eminent players who have won (small tournaments) high honours (never the highest), and who never play anything else, but either or both of these Openings. He admires the soundness of these masters (whom I may be pardoned in comparing to "penny automatics"—the machine on being set in motion plays 1. Kt to KB3, or 1. P to Q4 with inanimate uniformity). Well now, if a teacher modernised to that extent essays to teach a tyro how to play the noble game, he is placed in a position of extreme difficulty. If he is a man of wisdom he will endeavour to fascinate and cultivate Tyro's imagination—for the tyro wants to play *chess*—leaving the practice of his defensive philosophy, his surfeit of modern theories and principles to those disciples of the new cult, who neither love and practise chess as amateurs, nor care for, nor honour it, as a profession, but who have made a trade of playing in tournaments, and to whom therefore, not losing a half a point, by not incurring even a particle of risk, is of more importance than playing *chess*. But if he be foolish enough to say to the beginner that there is no salvation to be found except in the Ruy Lopez or Irregular, and that the acme of wisdom is to play for position only—*i.e.* apply the principles of Draughts to Chess, and that the grand result of all correct play is a drawn game, then he will probably do nothing else but excite a distaste for Chess in the minds of his pupils, most of whom cannot understand him, and would not assimilate his teachings. Moreover, he would be advocating unreliable, if not false doctrines; for his teaching, his new style of play, is only the reflex action of an imagination naturally deficient, or weakened in nature's course, and his theories only hold good and produce their effect against inferior attack; they would fail to make any impression on play conducted on the same basis, and would be dispelled like chaff before the wind when opposed to imaginative play of the highest order.

"Whitehaven" asks our opinion of "the feasibility or otherwise of a transposition from the Vienna Opening to the Centre Opening (Paulsen's attack). Thus—

1. P to K4	1. P to K4
2. Kt to QB3	2. Kt to KB3
3. P to Q4	3. P × P
4. Q × P	4. Kt to B3
5. Q to K3	

It appears to me that Black may with advantage refuse to play 3. P × P, and instead pin the Knight with 3. B to Kt5. [Quite right, I. G.] If there be no other way of avoiding the transposition, it would appear to strengthen the claims of the Centre Opening."

Not at all, for apart from Black's third move his position is the same as in the normal game, arrived at as follows:—

1. P to K4	1. P to K4
2. P to Q4	2. P × P
3. Q × P	3. QKt to B3
4. Q to K3	4. Kt to B3
5. QKt to B3	

We have now the same position as before. Black may play B to Kt5, and he will obtain a good development. The usual course, by proper play in this Opening, is not to play P to Q3, but, after B to Kt5, Black should endeavour to Castle, play his Rook to Ksq, and play P to Q4, when he will have a good game, somewhat in the following order:—

5.	5. B to Kt5
6. B to Q2	6. Castles
7. Castles	7. R to Ksq
8. P to B3	8. P to Q4, &c.

CONTENTS OF No. 48.

	PAGE
The Dragon-tree of Tenerife. By R. Camper Day	237
The Common Cockroach.—III. By E. A. Butler	239
Sketches in Evolution. By John Watson	241
The Economics of the Fog. By Richard Beynon	243
The Moon as Seen in the Lick Telescope. By A. C. Ranyard	244
Letters:—S. W. Burnham, W. H. Pickering, R. Chartres, A. J. Field	246
Dogs and Bears, in the Present and the Past. By R. Lydekker, B.A. (Cantab)	249
On Some Printers' Pranks. By the late R. A. Proctor	251
The Face of the Sky for October. By Herbert Sadler, F.R.A.S.	253
Whist Column. By W. Montagu Gattie	254
Chess Column. By I. Gunsberg	255

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